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THE MECHANICVILLE-SCHENECTADY POWER TRANSMISSION.

The latest and in many respects one of the finest power-transmission plants to be constructed is that now in process of erection between Mechanicville and Schenectady, N. Y. In THE ELECTRICAL WORLD of October 2 a brief account of the progress of the hydraulic work at Mechanicville at that date was given. In this week's issue Mr. Charles P. Steinmetz has described the electrical features of the plant. These are in some respects new and of great interest. At the receiving end of the line, in the General Electric Company's factory at Schenectady, eighteen miles from the dynamos, the 12,000-volt current will be received by two synchronous motors and three rotary converters. The ingenious method of maintaining a practically constant potential at the brushes of the rotary transformers is very interesting. The automatic control, by means of series transformers and synchronous motor-generators which feed the shunt fields of the rotary transformers, is both novel and ingenious, and promises to be highly satisfactory in practice.

While it is not so stated in Mr. Steinmetz's article, it is understood that a large proportion of the power developed at Mechanicville will be transmitted to Troy and possibly Albany. Neither of these places is very distant from the plant and the transmission described, to Schenectady, will utilize only one-third of the current to be generated. It is likely that some very interesting experiments in power transmission will be made on this line, feeding, as it does, the works of a great electrical manufacturing corporation, and no doubt its accessibility and its situation so near the large centres of population will make it a centre of attraction for many visitors. The hydraulic construction leaves almost nothing to be desired, except as regards the use of dynamos below the water level of the forebay. It seems that the example of the excellent engineering which has marked certain foreign water-power installation of this type—low head and large volume of water—where vertical shaft turbines are used with the dynamos at the top, well out of the way of any possible wetting, has been neglected. There is no reason why the vertical-shaft machine should not be preferred to the horizontal type for this kind of installation. The difficulties of balancing, lubricating and handling the former type are less than in the case of the latter, while the beautiful simplicity of plants designed on this principle commends itself at once.

NOVELTIES IN ENGINEERING.

In the plant of the Blue Lakes Water Power Company, a description of which is given in another column, there are two notable departures from customary engineering practice. The first is the complete absence of receivers, air-cushion chambers or relief valves of any kind on the pipe-line system. As the pipe line is some 3200 feet long, and has normally a head of 1000 feet at its lower end, with a velocity of flow of several hundred feet a minute when running at full capacity, the risk of omitting all relief measures would seem to be great. The engineer in charge has, however, evidently considered that prevention is better than cure, and instead of providing measures for relieving water hammer which depend for their action on the hammer itself, he has so designed his gates that the water cannot be shut off with sufficient rapidity to cause ramming. This necessarily forbids the use of governors controlling the flow of water, and the governors to be installed will regulate by diverting the stream from the wheel by means of hoods over the nozzles.

The other innovation is the use of direct-connected impulse wheels and generators, the shafts of which are hung in only two bearings,

the water wheels and the flywheels being overhung at either end. The almost universal practice of underhanging such heavy wheels running at high speeds makes this a rather daring experiment. Considered theoretically, however, the overhung arrangement would seem to have considerable advantages over a shaft with similar loads supported by two bearings, one at either end, in that the shaft resists the bending stresses as does a beam, the overhanging ends acting as cantilevers and tending to balance loads applied on the underhung portion. Comparing the method used at Blue Lake City, with machines using three bearings, it must be remembered that dynamo shafts are necessarily very stiff, due to the enormous bending forces set up in case of any eccentricity of the armature in the field of force. To distribute the load on such a stiff shaft uniformly on three bearings the latter must be lined up with almost mathematical accuracy, a difficult thing to accomplish in some instances. Any deviation from perfect trueness in the shaft will also cause great vibratory strains in a shaft supported stiffly at three points. The lining up of two bearings is obviously perfect under all conditions, the use of spherically mounted brasses allowing also for any lack of trueness in the shaft. The overhanging weights on the ends of these shafts should give no more trouble, if perfectly balanced, in motion than in rest. To be sure, in addition to the weight of the water wheel there is added the force of the jets striking the buckets, but this force undoubtedly introduces strains much smaller than those in the crank shafts of an engine with overhung cranks.

THE PARIS EXPOSITION.

The universal exposition which is to be held in Paris in 1900 will present one of the most excellent opportunities to American manufacturers for the introduction of their goods into Europe that can possibly be imagined. In no line of work is this so true as in that of electrical machinery and manufactures. The undoubted preeminence of American machinery has hardly been impressed upon our European neighbors with sufficient force. In France to-day there is considerable interest manifesting itself in electric traction. and the majority of the motors and other machinery employed are of American make. While Germany possesses excellent establishments for the manufacture of electrical machinery, their product cannot be compared with that of American shops, either in perfection of finish or excellence of mechanical design. It is true that the Germans are our equals at least in electrical designing, but there can be no question of the superiority of American machinery, whose greater fitness for its work and better mechanical design is always evident when a comparison between the two types is instituted.

The American commissioner to the Paris Exposition has secured 200,000 square feet of space for the exhibition of American manufactures. It is to be hoped that the electrical industries will be well represented. It is probable that by the time the exposition is well under way there will be the same activity in electric traction in the continental countries of Europe that there was in this country six or seven years ago. It certainly behooves the makers of electrical machinery on this side of the water to bestir themselves in anticipation.

CONDUCTIVITY MEASUREMENTS.

As the measurement of resistance is one of the most highly developed branches of electrical measurement, and as resistance data are among the most common, it seems strange that the allied subject of conductivity and its measurement should have received so little attention. While it is true that conductivity measurements can always be made in the form of resistance determinations, and that there is no unit in terms of which conductivity data can be given, it seems that the time has now come when makers and consumers of electrical conductors prefer to refer to their conductivity instead of their resistance. The convenient, simple and accurate method for making conductivity measurements described in another column is of interest, therefore and seems well worth the careful attention of those interested in this subject. Mr. Willyoung, to whom the development of this method is due, deserves great credit for reducing it to its present efficiency and simplicity.

ELECTRICAL INSULATION.

The study of electrical insulations has been, for some reason, greatly neglected, and data on the subject of the specific insulating qualities of the various raw materials used in the manufacture of commercial insulation seem to be entirely inaccessible, except possibly by the manufacturers. The series of articles by Mr. Frederick W. Phisterer, now appearing in The Electrical World, are of deep interest to those who desire to know something of the behavior of the raw materials of insulation under various physical conditions and in a large number of combinations. The results which Mr. Phisterer has reached betray a very thorough and painstaking investigation on his part, and seem to be of real and permanent value.

The continual increase of the pressures employed in electrical work, and the rapid growth of long-distance transmission plants require a more careful study of insulation than has yet been made. The strange fact that nearly every insulator now used is an organic substance has caused some doubt to be expressed as to their permanence. There is hardly any subject more worthy the attention of both electricians and chemists than the manufacture of a substitute for india rubber, which is both expensive and unstable. The cost of high-class insulation for wires and cables is now very great, and is a large item of expense in high-pressure installations. The whole subject is one which will repay study and investigation, and in which there are abundant opportunities for discoveries of great importance.

The Duty on Electric Light Carbons.

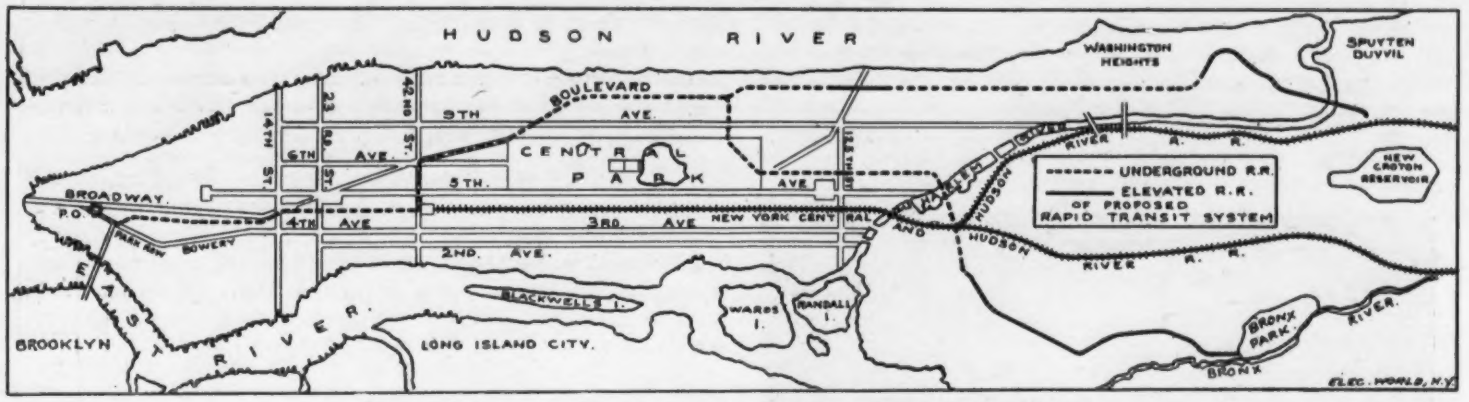
According to a dispatch from Washington, dated October 25, the question of duty on electric light carbons has been decided by the Customs officials. The opinion of the Treasury Department is that the duty of 90 cents a hundred should be based upon the length of the carbons as used in lamps. This will evidently prevent the further importation of carbons in lengths of 32 inches, under the Dingley tariff act, which provides a duty of 90 cents a hundred, without reference to size. Importers of carbons construed this section of the law as giving them the right to import carbons of any length at that rate. Appraiser Wakeman, at New York, however, did not so construe the provisions of the bill, and brought the matter to the attention of the Treasury Department, with the result as above noted. Reference was made to this subject in The Electrical World of October 16.

Telegraph Line to the Klondike.

Mr. Charles R. Hosmer, of Montreal, general manager of the Canadian telegraphs and general manager of the Pacific Postal Telegraph Company, and a director in the Commercial Cable Company, says that within the next year the Canadian Government will undoubtedly construct and complete a telegraph line to Dawson City, in the Klondike region, and by the identical route originally surveyed thirty years ago by George Kennan, the Siberian traveler.

Present Production of Aluminum.

According to the London *Electrical Engineer* the present production is said to be about 10 tons a day, of which the United States supplies 4000 pounds, Switzerland 5000, England 6000 and France 8000; the current price in England is about 33 cents per pound, and the cost of production about 27 cents, of which 12 cents is for the raw material.



MAP OF MANHATTAN ISLAND, SHOWING PROPOSED RAPID TRANSIT LINES.

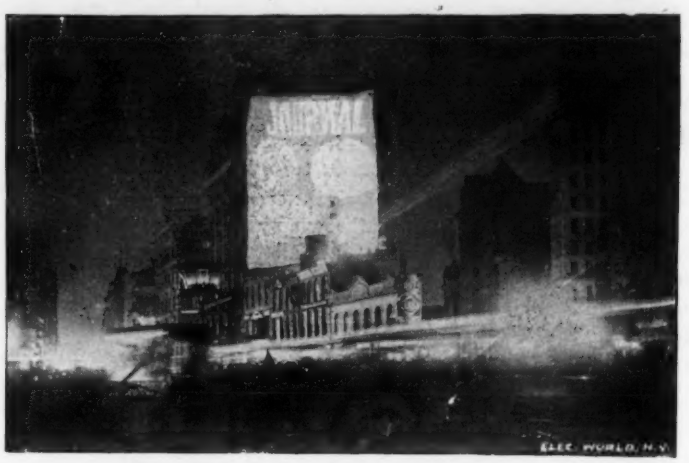
Progress of the New York Underground Rapid Transit Project.

On November 8 the commissioners appointed last summer by the Appellate Division of the Supreme Court to decide upon the practibility, desirability and advisability of the construction of the underground rapid-transit road rendered their decision. The rapid-transit problem in New York City has had quite a varied history. The project, originally laid out by the Board of Rapid Transit Commissioners, appointed several years ago, was argued before a commission and favorably reported by the latter to the Supreme Court, but unfavorably acted upon by that body on the score of expense. The Rapid Transit Commission again went to work and laid out a new project on a more modest scale, by which an estimated saving of $20,000,000 would be effected. The new plan provided for lines, as shown in the accompanying map, running from City Hall square, under Elm Street and Fourth Avenue, to Forty-second Street, thence to Broadway, and via Broadway and the Boulevard to near One Hundredth Street, there dividing, one line running north through Washington Heights and Inwood and crossing the Harlem River to Kingsbridge; the other line running diagonally under the corner of Central Park, thence through Harlem, across the Harlem River to the Annexed District, and on to a terminal near Bronx Park. The main change from the original plan was the elimination of the Broadway line, which would have been very expensive on account of the complicated pipe and conduit removals, and the abandonment of the Park avenue line up the east side of the city. This project has been brought into the courts by the opposing interests, the Appellate Division of the Supreme Court last summer appointing a committee of three citizens-at-large to look into the question in detail. The gentlemen of the commission were Arthur D. Williams, John Sabine Smith and George W. Young. Their decision was a most sweeping denial of the objections raised by the opposition.

These objections were in the main that, first, the proposed road would cost about $20,000,000 more than the estimate; second, that the road, if built, would not pay operating expenses and fixed charges; third, that the financial condition of the city renders it impossible for the city to undertake the work. The commissioners decided that there was great need for this system as proposed, and no serious objection to it; that it will not cost more than the estimated $35,000,000; that it will be possible for the city to issue the necessary bonds without approaching the constitutional limit of indebtedness; that it will be possible to construct the road and have it in operation within four years' time; and finally, that the road should be constructed and operated as proposed. The decision is so strongly in favor of the proposed road that it is thought that the Appellate Division will report favorably upon it. The question will come up before the latter body on or about the 22nd of November, and if the committee's report is confirmed, the next step will be the letting of the contract. The contract provides for the construction of the whole system and its operation by the contractors for a long term of years, the whole reverting to the city's ownership at the end of the period of operation. A strong company has been formed by Mr. Charles Sooysmith to bid for the contract. In all probability work will be actively under way in the course of a few months' time. It is to be fervently hoped that there will be no more serious delays in the accomplishment of this much needed improvement.

The Electrical Projection of Election Returns.

On the evening of November 2, the interest in the local campaign in New York City warranted unprecedented efforts on the part of the newspapers to display to the waiting crowds the returns of the election. Some of the scenes at prominent points are shown in the accompanying illustrations. The centre of greatest interest during the evening was perhaps Madison Square, New York City. The



ELECTRIC RETURNS PROJECTED BY LANTERNS ON THE CUMBERLAND WALL, MADISON SQUARE, NEW YORK.

brilliant illumination of Fifth Avenue and the great number of electrical signs on that part of Broadway render Madison Square almost as light as day on any evening. On the evening of election day the efforts at illumination provided by prominent newspapers rendered this square a veritable blaze of light.

A mammoth screen on what is known as the Cumberland wall is shown in one of the illustrations. The screen was 60 x 95 feet in dimensions, and on it were thrown four discs of light from as many projecting lanterns, beside the name of the newspaper across the top. The latter was thrown by a stencil plate in a projecting lantern, similar to those used for throwing the returns. All the lanterns that were used by this newspaper were of the "Criterion" type, made by J. B. Colt & Co. especially for this occasion. They were fitted with three-quarter inch soft-cored carbons, the current carried being 75 amperes. For the entertainment of the crowd, between announcements, one of the lanterns on the Cumberland wall was fitted with a projection microscope, by which the struggles between live insects and other small bugs were thrown, enormously magnified, on the screen.

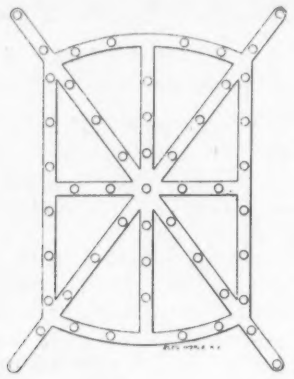
A searchlight projector specially made was also provided for throwing pictures to great distances. This lantern is of very interesting construction. The light is provided by 1-inch carbons, fed with 100 amperes of current. Eight-inch condensing lenses are used, and a specially made objective combination of six glasses, part of which are so mounted on a trombone-like slide that a new focus could be readily found. The glasses are so arranged that the angle of projection can also be readily changed within wide limits. These lanterns are mounted on universal bearings, and were used for projecting witticisms, pictures and advertising sentiments on the build-

ings in the neighborhood. It was intended to use them also for projection on the clouds, but this idea was abandoned for the reason that there were no clouds. Kites were flown during the evening, supporting enormous pictures of the various candidates for the most important office. When the successful candiate was known the searchlights were aimed at the proper kite supported picture, bringing it into view for miles. An amusing incident of the even-

"Crandall Letters." Madison Square, New York City.

ing's display was the effort of a rival newspaper with a plain searchlight to blot out the pictures thrown by the searchlight projector. The operators of the latter finally retaliated by projecting the name of their paper on the wall immediately below the searchlight of their rival, and therefore out of reach of the latter. This quickly brought the operators of the searchlight to terms.

On the north side of Madison Square the same daily paper arranged an enormous bank of changeable letters. These were of the



Arrangement of Lamps in "Crandall Letters."

Crandall type, a diagrammatic view of which is shown in the accompanying drawing. The letters consist of an arrangement of fifty-one lamps, so arranged that by lighting different combinations of the fifty-one lamps the various letters of the alphabet can be formed. The lights are fed in nineteen groups over a nineteen-wire cable, connecting them to nineteen cross bars on a keyboard. The depression of any one key of the keyboard closes the proper groups for the representation in light of the letter corresponding to that key. The keyboard is ingeniously fitted with an electromagnet so arranged that when any one key is depressed it held down until the magnet circuit is opened. The words are first set by the depression of the proper keys on the various keyboards, one for each letter, after which the main switch is closed. Arcing at the keyboard contacts is prevented by opening the main switch before the auxiliary switch controlling the magnets is opened. In the sign erected on Madison Square there were thirty-six letters and six figures, each letter and figure being approximately 3 x 4 feet in size. The whole sign was some 78 feet long x 35 feet in height. The returns were more readily announced by this sign than by any other means heretofore devised, the letters being legible at a distance of over one-half a mile.

On Newspaper Row the same paper placed a screen 125 feet x 50 feet in size, on which were thrown two 50-foot circles and one biograph picture. The details of the returns were thrown on these circles, another screen being used for the totals, which were frequently revised. The apparatus for illuminating these screens was fitted in a four-story tower temporarily built in the street. The lower story of this tower, which was of a trunacted-pyramidal shape, contained the biograph apparatus. On the second floor were the telegraph operators and expert slide writers. On the third floor were the projecting lanterns, and on the top the searchlight projectors. Many of the novelties and new effects were designed by Mr. R. C. Daniels, who was in charge of the work done for the New York *Journal*.

A Proposed Consolidation of Rubber-Covered Wire Interests.

For some little time an effort has been on foot to bring about a working arrangement among some of the principal companies engaged in the manufacture of rubber-covered wire. The competition for orders has grown so keen that many of the manufacturers claim that their plants are being operated at almost no margin of profit and even, in some cases, at a loss. The Electrical World is in a position to say that an understanding has practically been reached whereby about 70 per cent. of those interested will consolidate their interests.

Those who favor the amalgamation say that the desirability of some form of working arrangement, which would result in the decrease of expenses, was the controlling factor in the discussions that have taken place on the subject.

As is well known, each of the large manufacturing companies maintains in each of the larger cities a sales office, and the scheme of consolidation, which was suggested, proposed the amalgamation of these various interests into one large company, which should conduct its sales through a single office in each city, thus relieving the various manufacturers of the large expenses incident to the maintenance of these sales offices.

The outcome of the matter has been the formation of a plan whereby the various manufacturers are asked to agree to sell out their business and plants to a large corporation to be formed, this latter to conduct the whole of the business of selling the product. The capital stock of this corporation is not yet determined upon, but it is said that it will not be less than $5,000,000. It is said nearly 70 per cent. of the gross interests represented have signified their willingness to join the proposed organization, provided the details are arranged to their satisfaction. A feature of the plan is to be the specialization of the various factories now engaged in the manufacture of rubber-covered wire. Each branch of this industry will be conducted in the factory best adapted for it, and probably under the supervision and management of the present executive personnel in each case.

It is hoped in this way to maintain a high standard of product without materially increasing prices, and at the same time to lessen operating expenses.

It is claimed by some manufacturers that through such an organization, which would combine all the experience and capital of the rubber-covered wire industry, submarine cables and their laying could be undertaken in competition with foreign manufacturers, who now control the market in this line of work. It is said that there is no concern in the United States to-day properly equipped for the manufacture and laying of ocean telegraph cables, the majority of this work being done by English companies, and that there is no reason why this branch of the work cannot be successfully handled on this side of the water. It is claimed that the cost of the materials entering into the manufacture of such cables is no greater in this country than it is abroad, the principal difference being in the cost of labor.

It is thought by some of those interested that the preliminaries of the organization may be completed by December 1, or at least by January 1, although it is not impossible that the arrangement of the details may require some time longer.

Some well-known manufacturers of rubber-covered wire say such a combination is an excellent thing—for those who are not in it—and prefer to remain on the outside. It is stated, however, that while the matter is still in the preliminary stage, the amalgamation of about 70 per cent. of those in the business is practically an accomplished fact.

The Advantages of Electrical Distribution in Navy Yards.

The following letter, addressed to C. O. Matthews, Chief of Bureau Yards and Docks, and incorporated in his annual report to the Secretary of the Navy, gives a most lucid exposition of the advantages to be gained by the distribution of power in the navy yards by electricity from one central point:

DEPARTMENT OF THE NAVY,
BUREAU OF YARDS AND DOCKS,
WASHINGTON, D. C., October 4, 1897.

SIR—I have the honor to ask your consideration of the subject of the installation in the navy yards of central stations for the generation of electric power to be distributed to the various shops for the operation of all machinery.

The economy in operation resulting from centralizing or uniting all the plants is, I think, obvious to any person who has given the subject consideration. The distribution of the power electrically can be done with a negligible loss.

The economy to be effected results from various stages in the process of converting the potential energy of coal into mechanical work in the machinery.

Boilers—At present each department has one or more boiler plants, each plant requiring one or more firemen. The demands are generally below the capacity of the boilers, and the coal consumption high for the power utilized. If the total demand for steam for all engines could be brought to one point it would only be necessary to operate a sufficient number of boilers to supply it, the boilers then running under the proper conditions for coal economy. The number of firemen necessary would be materially reduced. Stopping at this point would involve the distribution of steam over long distances, an uneconomical operation.

Engines—Practically each shop has its own engine, a simple non-condensing one, and frequently of an old type. The engines run continuously on a partial load, a condition which, taken in connection with the type of engine, results in a large steam consumption for the amount of power realized. Each engine has its engineer. Suppose that this demand for power could be brought to one point, we could then operate a large, efficient, compound condensing engine, with a very large economy in the use of steam. But one, or at most two, engineers would be necessary.

Shafting—In all shops long lines of shafting are run continuously, whether the complement of men is large or small. The load of this shafting is from 25 to 50 per cent. of the capacity of the engine driving it, and it frequently constitutes the greater part of the load on the engines. If electric motors were installed in the shops the amount of shafting could be very much reduced, and only such parts of what remained as were necessary for the time being would be operated. All large machinery should be operated by individual motors, and the small machinery grouped on 7½ to 10-hp motors.

In any system of power distribution a certain percentage of the load on the engines is a waste load—that is, it is not utilized in the machinery driven by the engine. In a distributing system of belts and shafting this waste load is continuous, without regard to the amount of machinery in operation. As the machinery is stopped the percentage of waste load continually increases. In a system of electrical distribution of power, whenever a machine is stopped its proportion of the waste load is cut out, and the waste power remains a nearly fixed percentage of the power utilized. An example will render this clear: Suppose we have a 1000-hp plant, in which 80 per cent. of the power is realized in the machinery when it is all in operation—that is, 800 horse-power is useful energy and 200 horse-power is waste, belts and shafting. If now, due to a reduction of the force of men or other causes, three-fourths of the machinery is shut down, 200 horse-power will be utilized in the machines, and the 200 horse-power of waste in the belts and shafting will remain about the same, increasing the percentage of waste load to 50. In an electric system, if the useful load is reduced to 200 horse-power the waste load decreases in the same ratio, and will now be 50 horse-power, or 20 per cent. of the total, as before. When we consider the fact that the number of employees in the navy yard shops is continually changing, and that even with a fixed number the machinery is continually stopping and starting, it will be seen that this one item has a decided bearing on the economy of operation.

By the installation of a modern-power plant, composed of economical boilers with good coal and ash-handling facilities, compound condensing engines of a size to supply the average demands, and electric generators of an economical type, combined with a proper distributing system and motors for the machinery, economy will result from the following causes:

A larger percentage of the power supplied to the shops will be utilized in driving the machinery.

This power will be obtained from engines operating more economically.

The reduced steam consumption resulting from the above causes will be supplied from boilers operated under more economical conditions.

The number of employees connected with the present power, light and heating plants can be very much reduced.

Practical experience has not only demonstrated that power supplied in the form of electrical energy is the most flexible, convenient and reliable, but that it is also the cheapest. The result is most noticeable in American street railways, in which 13,580 miles, in a total of 15,250 miles, are operated electrically. Many private establishments have found that the saving in operating expenses was sufficient to warrant the large expenditure necessary in discarding their old plants and installing new electric plants. In establishing new plants no other system should be adopted.

In connection with the establishment of new plants, I wish to call your attention to the naval stations at Port Royal and Port Orchard. A small electric plant at each of these stations, installed with the pumping plants, could supply power to the present shops. It could be operated by the same employees, now on the rolls, who operate the pumping plants. A storage battery, charged during the working hours of the day, could be used to furnish light for the shops and quarters at night at very little additional cost.

The above is also true of the Navy Yard at League Island, Pa. By enlarging the present small plant, power could be supplied to the shops, and the lights already installed could be operated. The cost of supplying both power and light would be less than the present cost of supplying power alone. The necessity for supplying light to the ships in reserve at this yard, to the receiving ship, and for police purposes in the grounds, is imperative. It is probable that repair shops will be installed in the vicinity of the new basin. This machinery should be driven by electric power, as the demand will be irregular. If a steam plant is installed it will result in the permanent employment of the necessary engineers and firemen, thus adding to the already unnecessary number. If power is taken from the electric station no increase of employees over that necessary in running the plant in the first instance will be necessary. The increase of coal consumption in the electric station would be less than the coal consumption in the shop plant.

In accordance with your instructions, about a year since I made a careful investigation and estimate in regard to the supply of electric power in the Navy Yard at Norfolk, Va. The results are based entirely on known data, and are not theoretical conclusions. These results show that at least $12,000 per year, about 50 per cent. of the present cost of power, heat and light, can be saved by substituting a central electric power station for the present scattered plants.

In the Navy Yard, Washington, D. C., in which the most economical steam plant of any of the yards is installed, a large economy is possible by the substitution of electric power. In a careful investigation of one shop, made by running each machine and the shafting with an electric motor, and measuring the power used, it was found that the power wasted in driving the shafting was ample to run the machinery, if applied direct by means of electric motors.

A purely hypothetical case will perhaps best illustrate the gain to be made in centralizing the plants. Suppose we had one large shop containing ten large machines, or groups of machines, running intermittently; that some machines or groups required 50 horse-power, others 75 horse-power, others 100 horse-power, and so on, would any engineer install a separate boiler and engine, with their attendant firemen and engineers, for each machine or group? I think not. They would bank their boilers, reduce the number of firemen, and operate enough boilers to supply the average demand. They would install one or perhaps two large economical engines and correspondingly reduce the number of engineers. Now, suppose these machines to be scattered over a wider territory. In what way does it affect the result? Simply this, it renders transmission of power by belts or ropes uneconomical, necessitating separate engines; it renders steam distribution to these engines from one boiler plant uneconomical, owing to the condensation in long runs of steam piping, and necessitates scattering the boilers. Herein lies the essential difference between the present plants and an electric one. It makes no difference in the distribution of electric power whether the machines

to be operated are bunched in one building or scattered over an area larger than any of the navy yards. We can generate the power in one place and distribute it. The loss in distribution can be made as small as we wish. The demands for power in the various shops are added together at the switchboard, and we run only a sufficient number of engines and boilers to supply the aggregate demand. This enables us to employ the minimum number of engineers and firemen, and reduces the coal consumption to a minimum. Whenever the force of employees in the shops is reduced, the reduced demand for power is immediately shown in the power station, and the operating expenses are correspondingly reduced. Very respectfully,

O. G. Dodge, Professor, United States Navy.

Chief of Bureau Yards and Docks.

A Primitive Dynamo Factory and Power Station.

BY * * *

It was about the beginning of the year 1889 that certain misguided individuals in a small city of one of the Atlantic States undertook, without the least preparation in the way of either experience or capital, to build electric motors. The moving spirit in this enterprise was a man who had been by turns laborer, bridge builder, man in charge of an agricultural engine, miner, brass moulder, promoter in a small way, inventor all the time, machinist, foreman of a street railway repair shop and general jack at all trades. He had set himself up in a little cellar shop to manufacture commutators for the street railway company, whose foreman he had been, and incidentally ran a small brass foundry. When I first met him he had about completed arrangements to borrow a little money, use an abandoned turbine wheel at the site of a burned mill near the business centre of the city for the generation of electric power, and build motors to be operated on a power circuit of his own. Somehow he succeeded, and when, some months later, he offered me a position to design his motors and generally supervise his work, I thankfully accepted—that being a time when a "job" of any kind was a desideratum.

The shop was about 20 feet square, very dark and most unspeakably filthy. The tools consisted of a small planer, a very small shaper, an old-fashioned drill press, two ancient engine lathes and a die press, cutting discs up to about 7 inches diameter, all operated by an old Sprague No. 6 railway motor. There was also the ubiquitous brass furnace, flush with the floor in one corner, and a trough of sand for the use of the one moulder along one side of the room. At the two dirty windows were two benches, equipped with the usual outfit of bench tools, all in a very untidy condition.

The "power house," half a mile away, contained one 40-kw, 220-volt generator, new and in good condition, driven by a belt from a countershaft geared to the vertical shaft turbine of the ruined paper mill. There was water in abundance at an exceedingly low rental.

To my astonishment and surprise I found that the president—that was the position of my friend, the ex-foreman—had a patent which he had bought, presumably for stock, and I was required to conform my designs to the lines of this. As it had been imparted to me in confidence that the troubles of the shop centred in the fact that only one size of motor—5 horse-power—could be made to work from the design left by the patentee, my first duties were to make a set of drawings for various sizes of motors. To use the words of the president, other sizes had been attempted, but the "dum things either stood still and bucked or run so fast they bust."

We turned out some pretty creditable motors, everything being considered. Seeing that we had power to throw away we soon loaded our 40-kw machine to its limit, the condition being that we would allow no other motors than our own on the circuit. Motors were sold cheap, $85 for a 5 horse-power, as well as I remember, and business was brisk.

These motors were shunt wound, of a two-pole type, having a cast iron frame in two parts. The lower casting consisted of a pole piece, brackets for the bearing and a vertical core for the field coil. The frames were machined on our planer, bolted together, and set in a wooden cradle on the slide rest of the large lathe to be bored out. The field coil was wound on a sheet copper spool. The armature bearings were of brass, seating themselves in the brackets of the lower pole, which were bored out along with the field opening. The armatures were made of the then prevailing smooth-core type. The core was made of punchings headed up tight between collars on the shaft, one of which was screwed up with a spanner and main strength until the core was "about right" or the shaft sprung. The whole was then covered with unbleached cottton and shellaced, and holes bored in the cast iron heads for the reception of wooden pegs to guide the winder. No provision whatever was made for balancing, this being considered an unnecessary refinement in machines that were sold so cheap. The commutator bars were cast from wooden patterns, and afterwards worked on the shaper with a forked shaped tool, resembling more than anything else the nail pulling end of a hatchet. This gave them the necessary angle, and subsequent operations brought them down to reasonable fitness for their work. On the whole they were good commutators for the money, though it was soon found inexpedient to mix bars from different runs of the brass furnace in one commutator. The president had a deep seated affection for old brass bought from the junk man, and I have seen old railroad brasses, gas fixtures, door plates and the like melted up together to be turned into commutators. It is needless to ay that nobody could predict the color, hardness or any other quality of the resulting metal.

It was about this time when the loading of the circuits required an enlargement of the power plant, and the question came up for discussion whether it was better to buy a new (second-hand) generator or make one, that the president became imbued with the idea of doing electric lighting. We had the circuits, and the then newly introduced constant potential arc lamps worked very well in series of four on the 220 volts. It was decided to build a new generator, to install all the arc lamps we could find customers for, and to put in a new horizontal-shaft turbine. Meanwhile we bought a second-hand 30-kw, 500-volt generator, and replaced some of our more distant motors with others wound for this voltage. It may be said here that the prevailing sizes were two and five horse-power, the former predominating. It has always been a source of regret to me that we were never able to measure their efficiency, or their current consumption, or the output of the station, because we never had an ammeter. Incandescent lamps brought up to "look about right" answer fairly well as a station voltmeter. I tried to make an ammeter, but never had time to finish it.

It was while we were in the throes of installing the big turbine and getting out patterns for the 75-kw, 220-volt generator with which we proposed to help out the overworked dynamo at the power station that the president came in one day with the news that he had contracted to light the biggest and finest store in the town with 400 incandescent lights, and about 20 arcs. It was obviously impossible, in those days, to work incandescent lights on a 220-volt system. The wiring being in it was equally impossible to make a 3-wire installation of it. It was about a mile from the power-house, and I stood aghast at the idea of another generator for this load. The proprietor of the store would not listen to the suggestion of a motor-dynamo on his premises—and we had no money (or credit) wherewith to purchase an alternator. The result of a council of war was that the president undertook to get the transformers if I would immediately build the alternator.

In his enlightened day it does not seem possible to simultaneously build a 75-kw, 220-volt compound generator and a 50-kw alternator in a shop 20 feet square, with the outfit of tools described above, but we did it. The direct-current machine was comparatively easy, most of the machine work being "hired out" to other shops. We made the commutator ourselves, however, and did the winding. The machine worked fairly well; that is, it didn't get very hot in service or spark unduly at the brushes.

The alternator was a different sort of problem. In both this and the direct-current machine we were brought up standing by the difficulty of getting discs for the armatures. A simple, if somewhat barbarous expedient solved this, however. We cut up a number of squares of thin iron, about 20 inches square, and punched a 6-inch hole through the centre of each. These were then placed on a wooden template, and an 18-inch circle drawn on them with a slate pencil. Two able-bodied boys with tinsmith's shears did the rest. It was slow, but we got the discs. These, being clamped on the shafts, were subsequently turned up with much expenditure of labor and profanity. We had hired a small room near the shop, and there installed the pattern maker and winder, and there the work on the two big machines went along with comparative satisfaction.

The alternator was of a mongrel type, having 16 poles in its stationary field ring. The armature was mounted in centres on the bed of the planer and slotted, the coils being made on a wooden frame and slipped on. It may as well be stated here that the writer's knowledge of alternators was not large at that time.

It was a breathless moment when, the alternator being finished, we started it turning, brought it up to speed and threw on the exciter

current. As I have related we had no manner of measuring instruments. The transformers had not arrived, and it was determined to use twenty 50-volt lamps in series to see if we could get the expected 1000 volts out of the machine. A boy at the shop was delegated to mount the twenty lamps on a board and connect them in series. Unfortunately he connected them the only way he had ever seen lamps connected, and no one had time to see if the work was properly done. The board of lamps was hung from the ceiling of the dynamo room, and at the proper moment, all connections having been made, the main switch was thrown. Those who have seen a 50-volt lamp explode under a pressue of about 1200 volts, alternating, will know what the resulting pyrotechnic display looked like. It cannot be described.

The cut in the price of light made by the president when we got the alternating circuit going attracted the attention of the local electric light company, and our independent existence was brief. This tale has been told to show what the possibilities of electrical machinery are, and to illustrate what can be done in a small machine shop when necessity drives.

Conductivity Measurements with a Direct-Reading Conductivity Bridge.

BY ELMER G. WILLYOUNG AND H. P. HARTH.

Probably no electrical measurement, those of self and mutual induction not excepted, is generally regarded as so difficult and tedious as the determination, with a high degree of accuracy, of a very low resistance. By a very low resistance we mean a resistance ranging from 1-500 to 1-500 ohm or even less. Obviously, in the measurement of such a resistance no orthodox Wheatstone bridge method is suitable, since the contact resistances are likely to be as great as or greater than the resistance to be measured. Such measurements have generally been made, therefore, either by some special arrangement of the Wheatstone bridge designed to eliminate or allow

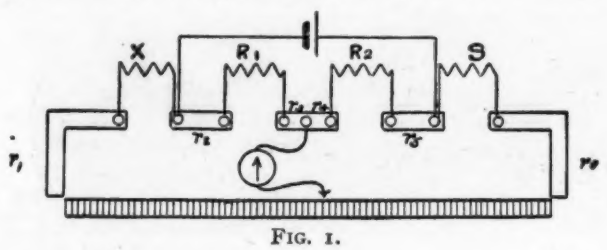


FIG. 1.

for these contact resistances, or else by some indirect method, as, for example, by comparing the P. D. produced at the extremity of the unknown resistance with that produced at the terminals of a second known resistance (the two resistances being in series) by an unknown but steady current.

Commercially we find such values of resistance as above to belong to copper conductors (No. 10 to No. 4 and larger) when in lengths of but a few feet. To accurately determine the resistance of such conductors per unit volume, or, to speak more strictly, to accurately determine the conductivity of such conductors is a problem of the highest importance. The requirements of long-distance telephony and submarine telegraphy in particular necessitate copper of the highest obtainable conductivity, and, since very slight traces of impurity greatly lower the conductivity, some method of accurately and quickly knowing the conductivity of the manufactured product from time to time becomes imperative. Having found all existing methods known to us for measuring such resistance unsatisfactory in some particular or other, we set ourselves the task something over a year ago of devising a more perfect method and appartus, In our endeavors we have met with the most signal success, and it is the purpose of this article to describe the method used and apparatus arrived at, together with some brief statement of its advantages as compared with other methods and apparatus.

THE METHOD.

The method employed is an adaptation of what is known as the "Carey-Foster" method of using the slide bridge,now acknowledged and used by the leading laboratories and manufacturers of the world as the most perfect method of the exact comparison of resistance standards.

In Fig. 1 we have a diagrammatic view of the "Carey-Foster" method. The bridge has four gaps, in which are four resistances, X, an unknown resistance, S, a standard resistance very nearly equal to X, and R_1, R_2, two auxiliary resistances each equal to one another, and approximately equal to X and S; r_1, r_2, r_3, r_4, r_5 and r_6 designate the connecting resistances of the permanent coppers of the bridge.

If now we obtain a balance, and then exchange S and X and balance again, we shall find that the unknown, X, differs from the standard, S, by exactly the resistance of the bridge wire over which the slider moves in changing from the one position of balance to the other when the resistances X and S are interchanged, the various connecting resistances r_1, r_2, r_3, etc., being eliminated and absent in the final result, *or* $X - S = \rho\ (x_1 - x_2)$ when ρ is the resistance of the bridge wire for unit length, and X_1 and X_2 the two balance readings. In the early part of 1892 it occurred to one of the writers, by whom this method and apparatus for its application had long been a special study, that a very simple inversion of the method would give a most beautiful method for the measurement of conductivity; that is, instead of determining an unknown difference from a known bridge wire, we might determine an unknown bridge wire from a known difference. A form of bridge for accomplishing this idea was therefore designed and built, and discussed in a paper before the American Institute of Electrical Engineers in the spring of 1892. In this apparatus, the coils X and S of Fig. 1 were replaced by two coils, each joined between two heavy parallel bars of copper. Six-shunt coils were then arranged so that by means of a short and massive connector anyone of the six could be parallel with one of the two main coils. In this way anyone of six standard differences $(X—S)$ could be established, the particular one chosen depending upon the size of coppar bar or wire being operated upon. To reverse this unknown standard difference a commutating device, consisting of massive copper bars built in a hard-rubber plate, and dropping into mercury cups, was employed. To reverse merely required lifting of the rubber plate and rotation through 180°.

This form of apparatus, while proving fairly satisfactory, had the very grave disadvantage that by having to actually *exchange* the two groups corresponding to X and S, and each of these groups being of necessity a very low resistance, great risk was incurred of a slight alteration of one or the other groups while reversing, due to a

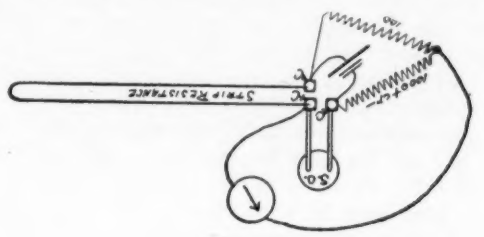


FIG. 2.

change in the contact resistance between commutator bars and mercury cups. The apparatus was also, for the same reason, extremely massive, and thus not only costly, but cumbersome. Various other minor details also were thought capable of improvement, and led to the devising of the apparatus which in its final and perfected state is now to be described.

THE DIRECT-READING CONDUCTIVITY BRIDGE.

The metal work of the bridge, with the exception of the clamps and binding posts, is of ¾ x ¼ inch copper, with brazed joints throughout, and mounted upon a mahogany base 1⅛ inches thick. S_1 and S_2 are two resistances made of No. 22 bare copper wire rolled into strips about ⅛ to 3-32 wide. Each strip is about 4 feet long, and stretched out in the open as shown, being supported and held in place by light wooden strips and hard-rubber clamps. These resistances are adjusted to 1-10 ohm each. M M are mercury cups at each end of the bridge at the junction of S_1 and S_2 with the bridge coppers. To obtain any desired standard difference a shunt of proper value is placed in parallel with S_1 and S_2 by means of the mercury cups M M, etc. Having obtained one balance with the shunt at one end of the bridge, the shunt is picked up and set at the other end and the second balance obtained. Thus, to obtain our known standard difference we do not exchange the two groups, S_1 and S_2 (paralleled with shunt), each of which groups is not more than 1-10 ohm, but merely the shunt (which is of high resistance), Thus we regularly employ 4 shunts, as tabulated below; the largest conceivable difference of mercury-cup resistance between the two ends of the bridge cannot, as is easily seen, affect our shunt by more than a few thousandths of 1 per cent., while the effect on the joint resistance of strip and shunt would be still less.

	Actual resistance of shunt in ohms.	Difference between the two groups in ohms.	B. & S. Gauge of copper to be measured with this shunt.
1.	28.471	.00035	No. 4 and No. 5
2.	13.233	.00075	No. 6 and No. 7
3.	4.900	.002	No. 8, No. 9 and No. 10
4.	3.233	.003	No. 11 and No. 12

The auxiliary resistances (R_1 and R_2 of Fig. 1) are in our bridge about one ohm each, also of copper wire. Their exact value is, of course, immaterial provided they be equal so as to keep the points of balance with any shunt at practically equal distances each side of the centre of the wire. These auxiliaries are inclosed in a little brass box provided with terminals, which fit into posts upon the bridge; in use they remain permanently in place. The wire or bar to be measured is clamped in front, as shown.

In adjusting the bridge, we build up everything from the standard ohm, starting with the strips S_1 and S_2. After rolling the strips, they must be thoroughly annealed before adjusting. We find this best accomplished by coiling a long length upon a reel and passing a current just large enough to heat, but not to badly oxidize the copper for a number of hours. Then cutting off the proper length, we arrange in Fig. 2, where S, O, is a standard ohm coil, and C, C, C mercury cups. The two left-hand arms may be obtained from any standard-resistance box in which the coils are properly adjusted among themselves. If now the strip is a little low, as it should be, it can readily be adjusted up to exactly 1-10 ohm by a little filing or rubbing with fine emery paper. The strips being adjusted, we may then get a first adjustment of the shunts by means of a regular Wheatstone bridge measurement. The final adjustment of each shunt may, however, be done against the standard ohm (as shown in Fig. 2) by placing it in parallel with the adjusted strip, and then adjusting until the joint resistance is the required value; thus for No. 4 shunt this joint resistance would be 0.097 ohm.

Strip resistances, shunts and auxiliaries, as also the metal part of the bridge proper, are of copper. It follows, therefore, that measurements with this bridge are independent of the temperature at which they are made, and are always in terms of the temperature, 70 degrees F., at which the bridge is standardized. To insure all parts remaining the same temperature the shunts and auxiliaries are wrapped in little mica frames, shellaced and inclosed in perforated-brass boxes, allowing free access of air. The strips, as has been said, are bare, and in the open, being merely cold lacquered when adjusted to prevent further oxidation. To prevent convection currents, as also heating of any part of the bridge by radiation, the bridge when in use is inclosed in a case (Fig. 3.) On the top of this case are binding posts for connection, and a key. The lid of this case is hinged to throw back, and is fitted on a bias so as to have a low front for ready insertion and removal of the wire under test.

The scale of the bridge is in 200 divisions to the foot,, subdivided by a vernier to fifths or to thousandths of a foot. A milled head rack and pianion movement operates the fine adjustment of the slider. which is always in contact. The battery key is on the top of the lid. The current furnished by two cells of dry battery in series has been found amply sufficient to operate this bridge when used with a suitable galvanometer. A D'Arsonval of the Rowland type, equipped with a low-resistance coil of about four ohms resistance, including suspensions, is employed. Such an instrument is very dead beat while at the same time very sensitive, even when used in close proximity to heavy machinery.

Thus far we have shown merely how the bridge can be used to determine the length of conductor corresponding to a given resistance. To obtain the conductivity, we must make use of the formula:

$$C = \frac{bll'K}{WR} \qquad (1)$$

where C = conductivity in per cent.

b = resistance of one metre-gram of copper at 70 degrees F. (Matthiessen's Standard) = 0.1536.

l = length of copper weighed.

l' = difference reading between the two balances.

K = constant = 0.0929 if W is in grams and l and l' in feet, (See Roebling's "Wire in Electrical Construction," p. 17.)

W = weight in grams of l.

R = resistance of l' = standard difference or shunt value.

It will be best always to work with the same length of copper sample. Suppose this to be 3 feet.

If now we suppose ourselves to be working with the No. 4 shunt, for example, we may write.

log b	.186391
log l (3 feet)	.477121
log k	.968016
	.631528
log R	.477121
	.154407

If now we add log l' and subtract log W from the result we have log C.

If we assume the weight of our test samples always the same, then we may write (8)

$$C = K' l' \qquad (2)$$

where K' is a constant, from which we see that C and l' vary inversely as one another. This may, of course, be expressed graphically. If now our sample should not always weigh the same for the same length, either by reason of slight variations of gauge or on account of difference of density, the curve above would not be strictly accurate. To provide for this, we have ascertained the maximum variation of weight for each gauge and a given length in commercial practice, and then split this up into eighty parts. A series of curves is then drawn—one curve for each of the above-determined weights.

Such a series of curves is shown in Fig. 4. The two axes represent respectively conductivity and length of conductor between balance points, *i. e.*, bridge difference readings. In practice we first take the conductor whose conductivity it is desired to learn, cut it off to the required length, and weigh it on an ordinary analytical balance; to do this, we need only to open the case door of the balance and lay the sample across one pan. Then place the test wire in the clamps, close the bridge case and get the two readings. Subtracting the one from the other gives us the difference reading. Now finding the curve corresponding most nearly to the weight of the sample, seeking the point of intersection of this curve with the vertical through bridge reading, and running out to the axis of ordinates gives us the conductivity.

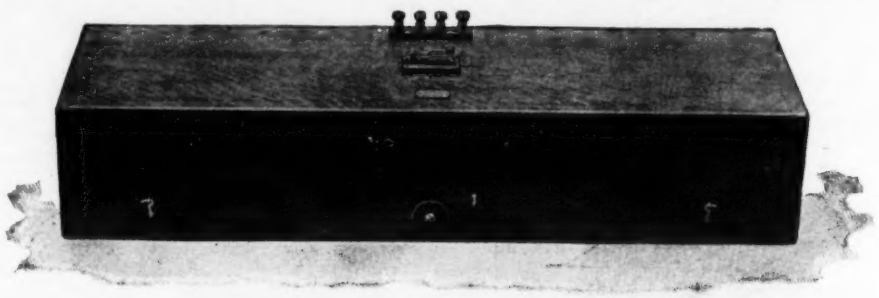


Fig. 3.

In a given case the test piece of No. 6 B. & S., 2.4114 ft. length, weighed 91,081 grams—the difference reading was 1842. This, we see corresponds to a conductivity of 96.58 per cent.

Instead of using the curves we may with almost equal facility obtain our result with the slide rule. For equation (8),

$$C' = \frac{b\,l\,l'\,k}{W\,R} \text{ may also be written } C = K'' \frac{l'}{W}$$

where K'' is a new constant made up of the old constants of (8) b, l, k, and R and l' = difference reading, and W the weight in grams of the standard length, just as in (8). One setting of the slide rule then gives the desired result.

While this bridge is essentially adapted and made for short lengths, and while generally there is the greatest economy in using short lengths, there are still many cases where only long lengths can be used. Such are, for example, very heavy rods and tubes regularly manufactured in 12 or 15-foot lengths. To cut off 2 or 3 feet for testing would be waste and mutilation. Such rods may be used in our bridge as readily as short ones by merely having the ends of the containing box slotted and the end clamps arranged to open at the top. The conductivity, of course, is still determined from the short length. If desired a *number* of observations may be made at various points of the same rod, and any *variations* of conductivity within a given length thus determined.

A number of these bridges have now been in use for several months in the test laboratories of some of the largest manufacturers.

Thanks to the kindness of one of these companies every opportunity has been given for observing and testing the performance of this bridge. The daily average of samples tested is about forty to fifty, about four hours being required for this work, including the recording of results and attachment of official tags to the samples. But one man is required for the work. The samples come to the laboratory cut roughly to 3-foot lengths; they are then cut to the exact length required by the tester. As to a constancy, and as going to show the perfect character of the electric annealing to which the resistance of the bridge are subjected during construction, careful tests of this bridge extending over a period of over six months have failed to show the slightest change.

We may check the constancy of the apparatus very quickly and easily at any time by keeping on hand a number of "Standard" copper rods, whose conductivity is accurately known. Indeed, the use of such standard rods enables us to adjust the bridge very much more quickly than by the method already outlined, and avoids any necessity of considering the temperature in initially standardizing the bridge. For, suppose we have determined a set of curves of conductivity, as in Fig. 4. Those curves may readily be made to suit any shunt, any length and any size of conductor by merely a slight alteration of the scales of value used, *i. e.*, the slope of these curves may be kept unaltered for such changes of condition as above. This being the case, suppose we have a standard rod of known conductivity and weight; all we need to do is to place the rod in the bridge, only approximately adjusted as yet, and find the difference reading corresponding to this conductivity. Then cause the appropriate weight curve to pass through the intersection of these two axes. It is obvious at once that our bridge is now correct at the standard temperature of the standard copper rod for the particular shunt used, and needs no further adjustment. For the other shunt we proceed in exactly the same manner.

Our thanks are due to Mr. William R. Webster and to Mr. F. J. Newberry for valuable criticisms and suggestions.

Military Telegraph Lines.

According to the report of Gen. A. W. Greely, for the year ending September 30, the aggregate length of military telegraph lines operated by the signal corps is 802 miles. This does not include the short cable line in New York harbor. General Greely states that highly satisfactory experiments were made with combined telegraph and telephone apparatus devised by Capt. James Allen, of the Signal Corps. The combination apparatus can be easily carried by an operator, and while one soldier telegraphs a message to another, a telephonic conversation with another station may be carried on over the same wire at the same time, the distant operators receiving only the messages intended for each. The oufit weights 16 pounds, including battery, and the system has been rigidly tested up to a distance of more than 600 miles. It is stated that it has given success in its various capacities as a "buzz" Morse telephonic and phonoplex instrument. General Greely states that this was the most notable advance of the year, and its importance, he adds, is not confined to field work of the corps alone, but its useful application may be made world wide.

Electric Railways in Canada.

In the "Canadian Year Book," recently issued by the Department of Agriculture of Canada, the total length of electric railways in the Dominion at the close of the year 1896 was stated to be only a little more than fifty-six miles of rail length.

Alternating-Current Machinery—XX.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

MUTUAL INDUCTANCE.—(*Continued.*)

169. If, instead of short circuiting the secondary coil we close it upon an external impedance, a change is produced in the system which is easily followed. We may first suppose that the external impedance is reactanceless, or consists entirely of a resistance of r ohms, with negligible inductance. The impedance of the secondary circuit is thus increased from $25 + j\ 30.16$ to $(25 + r) + j\ 30.16$. The apparent impedance of the secondary circuit in the primary circuit will now be $Z_{app} = -(j X_M)^2 Y_2$, where $Y_2 = \frac{1}{(25 + r) + j\ 30.16}$. As r is increased, we see from the chart, Fig. 113, that the secondary admittance Y_2 moves along the circumference of a circle of constant reactance, $x = 30.16$. This is shown in Fig. 120, where the vector secondary admittance $O\ Y_2$, commencing at $0.2551 \angle 50^\circ\ 21'$ mho retreats along the circle $Y_2\ y\ O$, as r is increased above 25, and finally, when r equals infinity, the vector admittance $O\ Y_2 = O \angle 0^\circ$. The corresponding apparent impedance Z_{app} is a vector $-(j X_M)$ or X^2_M, longer than $O\ Y_2$, and in the same direction as $O\ Y_2$. In other words, it is the vector $O\ Y_2$, of Fig. 120, to a scale 909.6 times larger. This is represented in Fig. 121, where the vector $O\ Z_{app}$ represents 23.21 ohms, and travels along the circle $Z_{app}\ z\ O$, as the secondary resistance is increased from 25 upwards. When the secondary resistance is infinity, the vector $O\ Z_{app}$, evidently becomes $O \angle 0^\circ$.

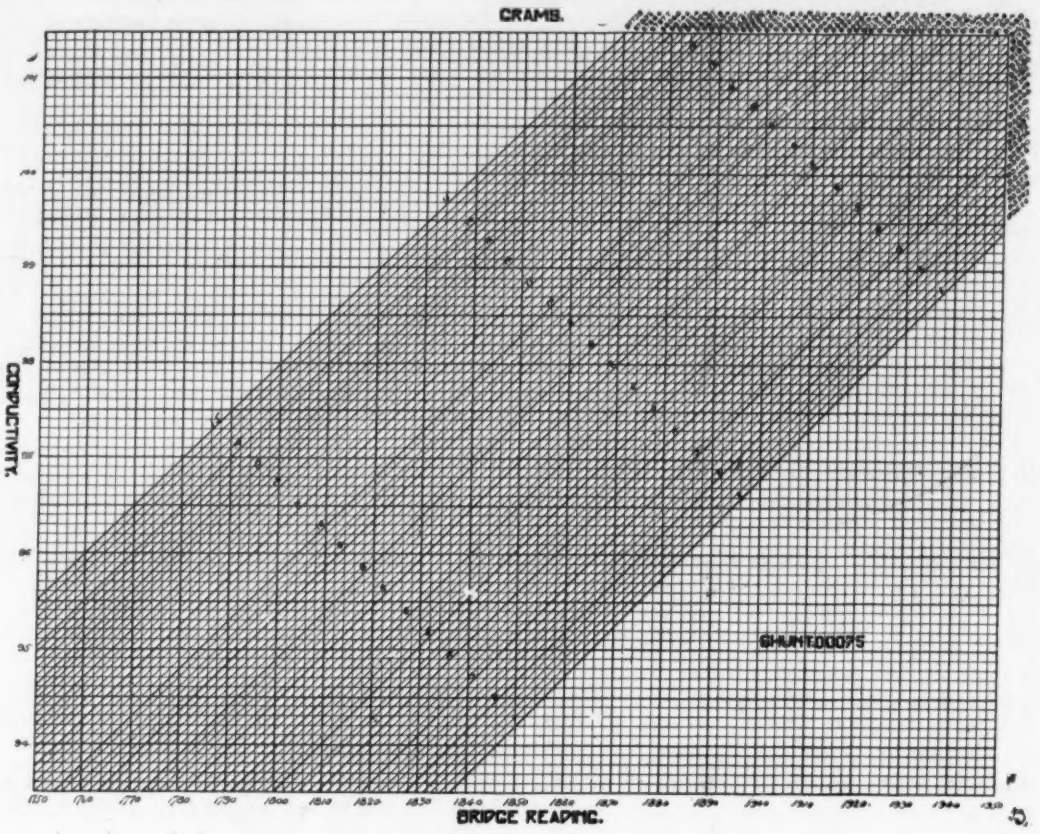


FIG. 4.

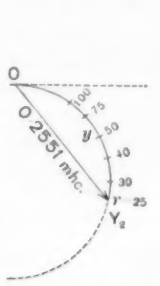


FIG. 20.—DIAGRAM OF SECONDARY CIRCUIT ADMITTANCE.

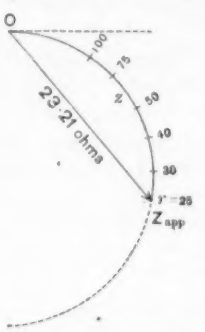


FIG. 121.—DIAGRAM OF APPARENT SECONDARY IMPEDANCE IN PRIMARY CIRCUIT.

The apparent impedance of the induction coil in the primary circuit is $Z_1 + Z_{app}$ and is seen in Fig. 122, to vary from $O\,Z$, when the external secondary resistance is zero, to $O\,Z_1$, when the external secondary resistance is infinity, following the circle $Z\,s\,Z_1$. It is evident that when the secondary circuit is broken, or has infinite resistance, the impedance of the induction coil is simply the impedance of the primary.

170. We may next suppose that the external impedance in the secondary circuit, instead of consisting of a simple resistance, consists entirely of reactance; *i. e.*, of an inductance coil, or condenser,

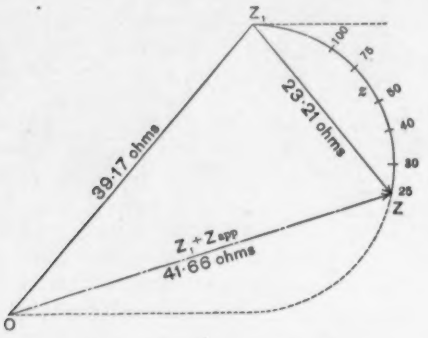


Fig. 122.—Diagram of Apparent Total Impedance of Primary when Secondary Resistance is Varied.

or both, with but negligible resistance. In this case Z_2 will increase from $25 + j\,30.16$ ohms to $25 + j\,(30.16 + x)$. Here x will be positive if we use a choking coil, and will be negative if we use a condenser in the external circuit. Taking first a choking coil, we may assume that its reactance may be increased indefinitely. By reference to Fig. 113, we may observe that the secondary admittance Y_2 will move along the circle of constant resistance $r = 25$ ohms, from the position $Y_2 = 0.2551\ /\underline{50^\circ\ 21'}$ mho, toward the origin as shown in Fig. 123, where the vector $O\,Y_2$ moves along the circular segment $Y_2\,y\,O$, as the secondary circuit reactance increases from 30 ohms to infinity. With infinite reactance the secondary admittance would be $0\ /\underline{90^\circ}$.

171. If now a condenser be placed in the secondary circuit, and so adjusted that its negative reactance steadily increases numerically, commencing with a large capacity and steadily diminishing it,

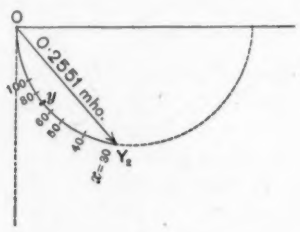


Fig. 123.—Secondary Circuit Admittance with Increasing Resistance.

the secondary admittance will move along the same circle shown in Fig. 123, but in the opposite direction. When the total reactance in the secondary circuit is zero; *i. e.*, when the negative reactance of the condenser, or condensance, is equal and opposite to the reactance of the secondary coil, $X_2 = \left(l_2\,\omega. - \frac{1}{c\,\omega}\right) = O$, the secondary circuit is resonant to the frequency of alternation, and its impedance is reactanceless, or behaves like a simple resistance, consequently the secondary admittance is a simple conductance $Y_2 = \frac{1}{25} = 0.04\ /\underline{0^\circ}$. As the capacity of the condenser is still further reduced, the reactance of the secondary circuit becomes negative, and its susceptance positive, so that the secondary admittance moves over the upper half of the circle, in Fig. 113 marked $r = 25$, until when the condenser is indefinitely small, and the negative reactance of the circuit indefinitely great, the admittance Y_2 becomes $0/\underline{90^\circ}$. Fig. 124 shows the corresponding diagram of the apparent secondary circuit impedance in the primary circuit. Commencing at $O\,Z_{app} = 23.21\ /\underline{50^\circ\ 21'}$ ohms, for a condenser of indefinitely large capacity, the vector $O\,Z_{app}$ travels around the circle through the points $x = 20$, $x = 10$, etc., until at secondary resonance, or when the condenser neutralizes the effect of reactance in the secondary coil, the apparent impedance in the primary is $36.38\ /\underline{0^\circ}$ ohms, or the secondary circuit behaves in the primary circuit like an ohmic resistance added to the primary. As the condenser is still diminished, the vector $O\ Z_{app}$ continues around the circle, diminishing in length and increasing in angle, until at an indefinitely small capacity it becomes $0\ /\underline{90^\circ}$.

172. It is thus practically possible by the use either of a inductance coil, or of a condenser, to cause the secondary circuit to behave, so far as the primary circuit is concerned, like an impedance which may have any angle from nearly -90° to nearly $+90^\circ$, traveling over a circle.

The total impedance of the induction coil in the primary circuit $(Z_1 + Z_{app})$ is shown in Fig. 125 for the same conditions. Here the vector $O\,Z$ travels around a circle whose diameter is $O^1\,Z$, the par-

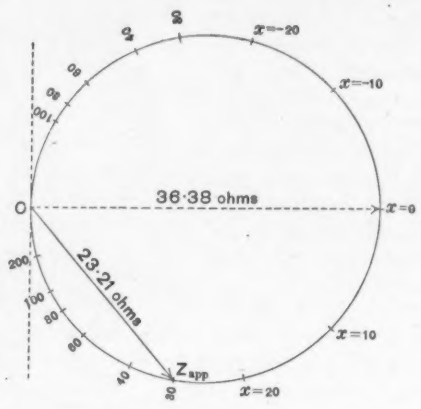


Fig. 124.—Diagram of Apparent Secondary Circuit Impedance in Primary Circuit as Secondary Reactance is Varied.

ticular point on this circle at which the vector lies depending upon the secondary circuit reactance.

173. It is to be observed that when the secondary circuit is resonant it virtually adds to the primary circuit **resistance only, *i. e.*,** it does not affect the apparent reactance of the primary circuit. Moreover, the resistance so added is a maximum for a given resistance in the secondary circuit. The

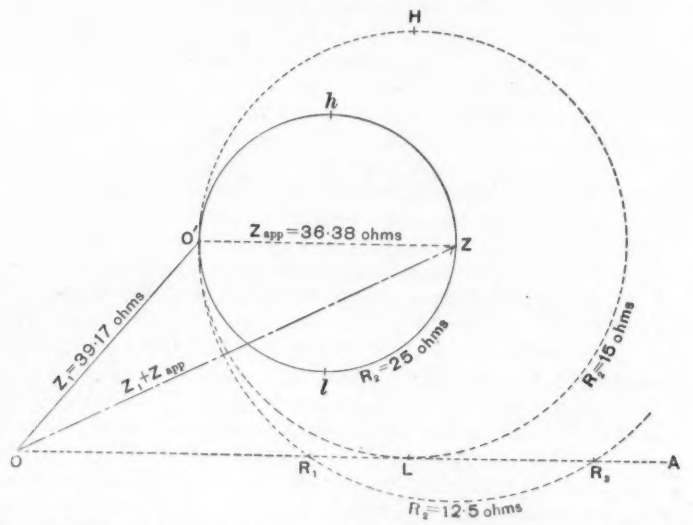


Fig. 125.—Diagram of Primary Impedance as Secondary Circuit is Varied.

smaller the secondary-circuit resistance, the larger will be the circle over which the vector Z_{app} runs, and the larger will be the virtual resistance added to the primary circuit at secondary resonance. If it were possible to have the secondary circuit resistance indefinitely small, the circle $O^1\,Z$, Fig. 125, would become indefinitely large, and with it the apparent resistance introduced in the primary circuit at secondary resonance. When the secondary circuit has negative reactance it virtually adds reactance to the primary, and when, on the contrary, the secondary reactance is positive, it virtually reduces the reactance in the primary. The reactance

virtually introduced into the primary circuit by the secondary is a maximum, when for a given resistance in the secondary the secondary admittance has an angle of 45°. This means that the reactance in the secondary circuit is numerically equal to the ohmic resistance. In this case the vector $O Z_{app}$ reaches either the lowest point *l*, or the highest point *h*, of its circle, Fig. 125. If the secondary-circuit resistance is small enough, the lowest point of the circle will touch the horizontal line *O A*, as shown at *L*, in Fig. 125, by the broken circle, which corresponds to a secondary-circuit resistance of $R_2 = 15$ ohms, for varying secondary reactance. In this case the effect of adjusting the secondary-circuit admittance to an angle of 45° degrees is to apparently cancel the reactance of the primary coil, and the induction coil behaves in the primary circuit like a simple ohmic resistance, *O L*, of 55.6 ohms. In this condition the current in the primary coil will be in phase with the pressure at the primary terminals, a condition which has been termed *consonance* by Professor Pupin. At a reactance in the secondary circuit of equal value, but opposite sign, at which the secondary admittance has an angle of 45°, the vector Z_{app} will touch the top of the circle at *H*, and the reactance of the induction coil in the primary circuit will be virtually doubled by the effect of the secondary circuit.

174. If the secondary resistance were still further reduced, the diameter of the circle over which the vector *Z* travels would be still further increased, and it would cut the horizontal line *O A* in two points, R_1 and R_2, instead of just touching it at one point. This would mean that there would be two values of the reactance in the secondary circuit, which produce zero reactance or consonance in the primary circuit.

175. Consonance in the primary circuit will, therefore, be produced either at two values of secondary reactance, or at one value of the secondary reactance, or at no value of the secondary reactance, according to the amount of reactance in the primary circuit and the amount of resistance in the secondary circuit.

176. We have seen that a variation of resistance alone in the secondary circuit causes the secondary impedance, the secondary admittance and the total apparent impedance of the primary to travel over the arc of a circle. In the same way variation of reactance alone in the secondary circuit will cause the vectors representing these quantities to travel over the arcs of a circle, intersecting the first at right angles. Any change in the secondary circuit consisting both of resistance and of reactance will produce a change in these quantities capable of being represented by a movement first over one circle for, say, resistance alone, and then over an intersecting circle for reactance alone. These rules readily enable the currents and pressures in an induction-coil circuit to be determined for a simple sinusoidal E. M. F., and in induction-coil circuit without iron. We shall see later that a comparatively slight modification of the same rules will enable them to be applied to the general case of any alternating E. M. F., and any induction coil having an iron core.

A Study of Electrical Insulation.—II.

BY FREDERICK WILLIAM PHISTERER.

REFINED CALIFORNIA ASPHALT.

This material was obtained from the Barber Asphalt Paving Company.

It easily received a dent or scratch of the finger-nail. It was very tough and difficult to break, even with hard, sudden blows. It did not crumble like refined Bermuda asphalt, but broke more like refined Trinidad asphalt. Thin pieces could easily be bent in the fingers and even twisted without breaking. The surfaces of the breaks were fairly smooth and of a dull black color. This material also showed quite a marked flow.

It melted at 295° Fahr., and though fluid was rather thick, it solidified slowly, and when solid was rather hard and not easily scratched. When cold it broke easily, the breaks showing a slightly rough, dull black surface. When warmed slightly it bent easily in the fingers when the pressure was applied slowly. It bent to a certain point and then the break occurred suddenly. It was a little tough and slightly sticky, and showed some little flow under pressure.

This material alone had its melting point at 295°, and although it was a little sticky and showed some slight flow, it was too hard and brittle to be used as an insulation. The adding of refined Trinidad asphalt would only increase this hardness and brittleness. Refined Bermuda asphalt would also increase the hardness and brittleness. The presence of crude Trinidad asphalt seemed to have little or no effect in changing the properties of refined California asphalt alone. Mixtures containing No. 1 refined Trinidad asphalt showed a decided increase of brittleness. Small quantities of soft coal-tar pitch did not change the melting point; quantities greater than one-half lowered the melting point only to 275°. All proportions of soft coal-tar pitch greatly increased the flexibility, toughness and flow; large proportions so much so that the mixture was but slightly brittle on chilling. Mineral wax lowered the melting point to about 220°, and in the larger proportions made a mixture that was still slightly flexible when chilled. The addition of sapho markedly lowered the melting point, but did not increase the flexibility to any extent. Adding ozite decidedly lowered the melting point and made a flexible mixture which, however, was brittle at ordinary temperatures to sudden blows. Paraffine wax would markedly decrease the melting point, but affect the hardness and brittleness very slightly.

Mixtures of refined California asphalt and refined Trinidad, refined Bermuda, crude Trinidad, No. 1 refined Trinidad asphalts, sapho or paraffine wax, were very unsatisfactory on account of their hardness and brittleness.

Mixtures of refined California asphalt and soft coal-tar pitch, mineral wax or ozite were very flexible, and showed a marked flow, mixtures containing a large proportion of soft coal-tar pitch being especially satisfactory on account of the slight effect caused by chilling.

CRUDE TRINIDAD ASPHALT.

This material was obtained from the Warren Chemical & Manufacturing Company, of New York.

It was in small pieces, hard and decidedly brittle, breaking with irregular surfaces of a dull black color. Small pieces broke easily in the fingers, without signs of bending. After the material had stood for some time, there were very slight signs of flow.

As melting this substance would be practically distilling it, since at even a low heat fumes were driven off, no attempt was made to get its melting point, and it was used in combination with the other substances simply to show the effect of combining them with the crude material.

It could not be used as an insulation because of its extreme hardness and brittleness. Refined Trinidad asphalt added to it would decrease the hardness and brittleness very slightly, if any. Refined Bermuda asphalt would act in the same way. Refined California asphalt would cause practically no change in the physical properties. No. 1 refined Trinidad asphalt would more noticeably decrease the hardness and brittleness, but the mixture would not be satisfactory as an insulation. Soft coal-tar pitch very markedly increased the toughness, flexibility and flow when present in large proportions. Mineral wax, sapho and ozite would all cause a marked decrease in hardness and brittleness. Paraffine wax would but slightly decrease the hardness and brittleness.

Mixtures of crude Trinidad asphalt and refined Trinidad, refined Bermuda, refined California asphalts, or paraffine wax, would not be suitable for insulations on account of their extreme hardness and brittleness.

Mixtures of crude Trinidad asphalt and soft coal-tar pitch, mineral wax, sapho or ozite would make fairly satisfactory insulations when the latter materials were present in large proportions.

NO. 1 REFINED TRINIDAD ASPHALT.

This substance was also obtained from the Warren Chemical & Manufacturing Company, and was the product obtained by refining the preceding substance.

It was hard, but not very brittle, requiring repeated blows to break it. It broke into rather large pieces, having fine grained surfaces of a dull black color. Small pieces broke in the fingers with hardly any sign of bending. The flow, if any, was not strongly marked.

The temperature of the melting point was 295° Fahr., and when melted the mixture was rather thick. It solidified slowly. When cold it was hard and not easily scratched. It was brittle when cold, but after warming slightly in the fingers very thin pieces could be bent a little. The break occurred suddenly with a snap. There was no flow noticeable, even after some time.

It could not be used alone as an insulation, because of its extreme hardness and brittleness. The addition of refined Trinidad would cause very little, if any, change in the properties of the mixture. The effect of refined Bermuda asphalt would not be marked at all. Adding refined California asphalt would cause a very slight decrease in the brittleness. Crude Trinidad asphalt lowered the melting point, and decidedly increased the hardness and brittleness. The presence

of soft coal tar pitch in large quantity decreased the melting point to 250°, and although it also increased the toughness, flexibllity and flow, the mixture was still brittle under sudden blows or pressure. Mineral wax lowered the melting point to about 255°, and increased very markedly the toughness, flexibility and flow. In equal parts with No. 1 refined Trinidad asphalt the mixture was only slightly brittle on chilling. Mixtures containing sapho had a melting point at 250°, and though very flexible sticky and showing a decided flow, they were quite brittle to sudden blows. Mixtures containing ozite had a melting point ranging from 275° to 240°, depending upon the quantity of ozite present. All were very flexible and had a decided flow, but only the last was not easily fractured by sudden blows, and that was only slightly brittle when chilled. Paraffine wax would markedly lower the melting point, and slightly decrease the hardness and brittleness.

Mixtures of No. 1 refined Trinidad asphalt and refined Trinidad, refined Bermuda, refined California, crude Trinidad asphalts or paraffine wax were too hard and brittle to be of use.

Mixtures of No. 1 refined Trinidad asphalt and soft coal-tar pitch, mineral wax, sapho or ozite were very flexible, tough and showed a decided flow, but were brittle to sudden blows, except mixtures containing a large proportion of soft coal-tar pitch or ozite, which were only slightly brittle on chilling.

SOFT COAL TAR PITCH.

This material was obtained from the Warren Chemical & Manufacturing Company.

It was very tough and was broken with difficulty, and only after repeated heavy sudden blows. It broke into rather large flakes, having very fine-grained surfaces of a shiny black. It was so soft as to be easily dented with the fingers, and quite large pieces bent without difficulty and showed a tendency to straighten out again. The flow was strongly marked and rapid, but a few moments being necessary to quite firmly join two pieces.

It melted at 210°, and became very fluid, solidifying very slowly only on cooling. Even when cold it was easily dented with the fingers. At 32° it was very brittle, breaking into small pieces with concoidal smooth shiny-black surfaces. At ordinary temperatures it was easily bent, twisted or moulded in the fingers. The flow was very marked.

It had a melting point at about 210°. It was tough, flexible under slow pressure, and had a decided flow. It was, however, brittle to sudden blows. It would do but indifferently well as an insulation. Large proportions of refined Trinidad asphalt would raise the melting point, but also greatly increase the hardness and brittleness of the mixture. Refined Bermuda asphalt would have the same effect. Refined California asphalt would but slightly raise the melting point, but would markedly increase the hardness and brittleness. The presence of crude Trinidad asphalt slightly lowered the melting point and markedly increased the hardness and brittleness of the mixture. Adding No. 1 refined Trinidad asphalt raised the melting point, but also increased the hardness and brittleness of the mixture. Adding mineral wax in proportions greater than 4 to 1 raised the melting point to 230° and increased the toughness, flexibility and flow so much that chilling had little or no effect on these properties. Sapho in the mixture lowered the melting point about 15°, and very greatly increased the toughness, flexibility and flow, even when chilled. Ozite acted very much like sapho. Paraffine wax would not combine.

Mixtures of soft coal-tar pitch and refined Trinidad, refined Bermuda, refined California, crude Trinidad, No. 1 refined Trinidad asphalts or paraffine wax, could not be used as insulations on account of their extreme brittleness and freedom from flexibility and flow.

Mixtures of soft coal-tar pitch and mineral wax, sapho or ozite were very satisfactory, have a toughness, flexibility and tendency to flow but little affected by chilling. Mixtures of soft coal-tar pitch and mineral wax also had the advantage of a rather high melting point, 230° Fahr.

MINERAL WAX.

This substance, known commercially as the Siemens & Halske Insulation, is marketed by the General Electric Company, and was obtained from it.

It was quite hard and very tough. After repeated heavy, sudden blows it broke with a conchoidal fracture. It was very flexible if bent slowly, sudden bending acting like a blow and causing fracture. The surface of the break was somewhat uneven, and had a peculiar green tinge. In some places this color changed to brown.

It melted at 235°, and was then rather thick and heavy. It solidified very slowly only on cooling. Even at 32° it was very tough and sticky, and difficult to break, even with heavy, sudden blows. It was of a greenish-brown color. The surface of the break, if caused by a sudden blow, was smooth, fine-grained and shiny. If caused by bending or twisting, it was granular. At ordinary temperatures it could hardly be broken, it was so tough and flexible. The flow was very marked. These properties were all very marked, perhaps more so than before melting.

The melting point was about 235° F. Adding refined Trinidad asphalt would slightly increase the melting point, but would also increase the hardness and brittleness, proportional to the amount of asphalt. Increasing proportions of refined Bermuda asphalt would raise the melting point and increase the hardness and brittleness. Refined California asphalt would slightly lower the melting point, besides increasing the hardness and brittleness. Crude Trinidad asphalt made hardly any difference in the properties of the mixture. No. 1 refined Trinidad asphalt raised the melting point about 25°, but also increased the hardness and brittleness. Soft coal-tar pitch did not affect the melting point, but somewhat increased the hardness and brittleness. Adding sapho slightly lowered the melting point, but very markedly increased the toughness, flexibility, stickiness and flow, so much so that it was hardly brittle even when chilled. Ozite also slightly lowered the melting point, and increased very markedly the toughness, flexibility and flow. This mixture was, however, rather brittle when chilled. Paraffine wax lowered the melting point about 20°, and decreased the toughness and flexibility and increased the brittleness. Hard coal-tar pitch "SSS" in a ratio of one to one raised the melting point about 30° without decreasing very much the toughness, flexibility and flow. Hard coal tar pitch "O" in the same ratio would not change the melting point, and but slightly increase the hardness and brittleness.

Mixtures of mineral wax and refined Trinidad, refined Bermuda, refined California, crude Trinidad, No. 1 refined Trinidad asphalts, soft coal-tar pitch or paraffine wax would not be satisfactory as insulations on account of their hardness and brittleness.

Mixtures of mineral wax and sapho or ozite would have a slightly lower melting point, but a markedly increased toughness, flexibility and flow.

Mixtures of mineral wax and hard coal-tar pitch "SSS" would have a raised melting point, and but slightly decreased toughness, flexibility and flow.

Mixtures of mineral wax and hard coal tar pitch "O" would show no change in melting point, and but a slight increase of hardness and brittleness.

SAPHO.

This material was obtained from the New York & Ohio Company, of Warren, Ohio.

It was a reddish-brown compound, very thin pieces being almost a yellow. It was slightly translucent. It was quite sticky, and had a decidedly resinous smell and general appearance. At ordinary temperatures there was a very decided flow. It was quite brittle under sudden blows, the fracture closing very quickly. It was rather flexible at ordinary temperatures under slow pressure. When chilled it was decidedly brittle, but still showed some flow.

It was melted with a very slow heat, so as to give off no fumes. It became a slightly heavy, transparent, reddish-yellow fluid at 220° Fahr., and solidified very slowly. After solidifying no change from the properties noted above was to be noticed.

The melting point was 200° Fahr. Refined Trinidad asphalt caused a rise in melting point and a marked increase in hardness and brittleness. Refined Bermuda asphalt raised the melting point considerably and markedly increased the hardness and brittleness. Adding refined California asphalt slightly raised the melting point and very markedly increased the hardness and brittleness. Crude Trinidad asphalt caused a drop in the melting point of about 20°, and very markedly increased the hardness and brittleness. No. 1 refined Trinidad asphalt raised the melting point about 50° and markedly increased the hardness and brittleness. Soft coal-tar pitch lowered the melting point about 10°, and but slightly increased the hardness and brittleness, though the mixture would still be rather tough, even when chilled. Mineral wax would raise the melting point about 10°, and the mixture would be so tough and flexible as to be but slightly brittle, even when chilled. Ozite raised the melting point about 25° and increased the toughness, flexibility and flow of the mixture at ordinary temperatures, although it was decidedly brittle when chilled. Paraffine wax increased the brittleness and slightly raised the melting

point. Hard coal-tar pitch "SSS" raised the melting point about 40°, and only very slightly increased the hardness and brittleness. Hard coal-tar pitch "O" also raised the melting point about 40°, but very markedly increased the hardness and brittleness.

Mixtures of sapho and refined Trinidad, refined Bermuda, refined California, crude Trinidad, No. 1 refined Trinidad asphalts, paraffine wax or hard coal-tar pitch "O" would not be satisfactory, on account of their hardness and brittleness.

Mixtures of sapho and soft coal-tar pitch or ozite would be fairly satisfactory where there will be little danger of sudden blows or chilling.

Mixtures of sapho and mineral wax or hard coal-tar pitch "SSS" would be very satisfactory, the former because it is not brittle, even when chilled, and the latter because of its very much higher melting point without any special loss of toughness, flexibility and flow.

OZITE.

This material, known also as the Waring Compound, was obtained from the Standard Underground Cable Company, of Pittsburg, Pa.

It was black and sticky and showed a decided flow. It was hard to fracture, and the breaks mended almost at once. At ordinary temperatures it was easily moulded. When chilled it was somewhat more brittle, but still required sudden heavy blows to cause fracture. It also still showed decided signs of flow.

Under a slow heat it melted without giving off any fumes, at 180° Fahr. When melted it was rather thick, but perfectly fluid and solidified only on cooling. No change in its properties could be distinguished after solidifying.

Ozite by itself melted at 180° Fahr. Adding refined Trinidad asphalt would cause a considerable rise in the melting point, but it would also increase the hardness and brittleness of the mixture. Refined Bermuda asphalt would rise the melting point about 50°, and increase the hardness and brittleness. Refined California asphalt would increase the hardness and brittleness, and raise the melting point an amount depending on the proportion of asphalt in the mixture. Crude Trinidad asphalt raised the melting point about 10°, and caused a marked increase in the hardness and brittleness. No. 1 refined Trinidad asphalt raised the melting point from 50° to 75°, but markedly increased the hardness and brittleness. Adding soft coal-tar pitch would raise the melting point about 10°, and would slightly decrease the toughness, flexibility and flow. Yet the mixture would be but slightly brittle even when chilled. Mineral wax would slightly raise the melting point, and the mixture would be only slightly brittle when chilled. The addition of sapho would raise the melting point from 20° to 45°, depending upon the proportions of sapho in the mixture. When chilled this mixture would be decidedly brittle, though very tough, flexible and sticky, having a marked flow at ordinary temperatures. Paraffine wax would not combine at all. Hard coal-tar pitch "SSS" would raise the melting point 80°, but very markedly increase the hardness and brittleness. Hard coal-tar pitch "O" would raise the melting point about 45°, but the mixture would be but slightly flexible, even after warming.

Mixtures of ozite and refined Trinidad, refined Bermuda, refined California, crude Trinidad, No. 1 refined Trinidad asphalts, hard coal-tar pitch "SSS" or hard coal-tar pitch "O" would not be satisfactory as insulations on account of their extreme hardness and brittleness.

Mixtures of ozite and soft coal-tar pitch or mineral wax would be so tough, flexible and sticky, and have so marked a flow as to be but slightly brittle when chilled.

Mixtures of ozite and sapho would be very satisfactory at ordinary temperatures, but would be decidedly brittle when chilled.

PARAFFINE WAX.

This material was the ordinary commercial white paraffine wax, too well known to need further description.

It melted at 180° Fahr., becoming very fluid, and solidified only on cooling. When again solid it displayed the same physical properties, so far as could be discovered, that were noticed before melting.

It is not recommended as an insulation, because, besides its rather low melting point, it has a tendency to absorb moisture. Adding refined Trinidad asphalt raised the melting point a great deal, but made the mixture hard and brittle. Refined Bermuda asphalt raised the melting point about as much, and when in equal proportions with the paraffine wax the mixture was fairly tough and flexible, though easily fractured. Only in the larger proportions was the wax all combined with the asphalt. Although the refined California asphalt raised the melting point, it made the mixture hard and brittle. Crude Trinidad asphalt slightly raised the melting point and markedly increased the hardness and brittleness. No. 1 refined Trinidad asphalt also raised both the melting point and the hardness and brittleness. It was found that paraffine wax would not combine with soft coal-tar pitch in any proportion. Mineral wax raised the melting point about 30° and increased markedly the toughness, flexibility and flow. In large proportions sapho raised the melting point and increased the toughness, flexibility and flow. Paraffine wax and ozite would not combine.

Mixtures of paraffine wax and refined Trinidad, refined California, crude Trinidad or No. 1 refined Trinidad asphalts would not be suitable for insulations, because of their hardness and brittleness. Soft coal-tar pitch and ozite would not combine with paraffine wax.

Mixtures of paraffine wax and large proportions of refined Bermuda asphalt or sapho would be fairly satisfactory where the chances of rough handling or chilling were not great. Mixtures of paraffine wax and large proportions of mineral wax would be quite satisfactory. They all have rather high melting points and are tough, flexible, and have a marked flow.

HARD COAL-TAR PITCH.

This material was bought from Schoellkopf, Hartford & Maclagan, of New York City, and by them especially designated by the letters "S S S."

It was very hard and very brittle, breaking into small pieces under light blows. The surfaces of fracture were concodial, very fine grained, smooth and shiny black.

It melted at 265° Fahr., and though rather thick was fluid enough to pour easily. It solidified quickly, and then, so far as could be detected, displayed no change whatever from its physical properties before melting.

It could not be used by itself as an insulation on account of its extreme hardness and brittleness. It was thought worth while to make mixtures of this substance and such other materials only as were in themselves tough and flexible, and had a marked tendency to flow. Adding mineral wax made no particular change in the melting point, but when present in large quantities made the mixture very tough and flexible, and markedly increased the flow. Sapho lowered the melting point about 25°, and without affecting the hardness and brittleness increased the flexibility and flow. Ozite did not affect the melting point, the hardness nor the brittleness, but very slightly increased the flexibility of thin pieces.

Mixtures containing hard coal-tar pitch and mineral wax, with large proportions of mineral wax, would be quite satisfactory as insulations.

Mixtures of hard coal-tar pitch and large proportions of sapho would be fairly satisfactory where the danger of sudden blows was not great.

Mixtures of hard coal-tar pitch and ozite would not be satisfactory.

HARD COAL-TAR PITCH.

This material was bought from the same firm as the former and was by them designated by the letter "O."

It was very hard and very brittle, breaking into small pieces under light blows. The surfaces of fracture were concoidal, very fine grained, smooth and shiny black.

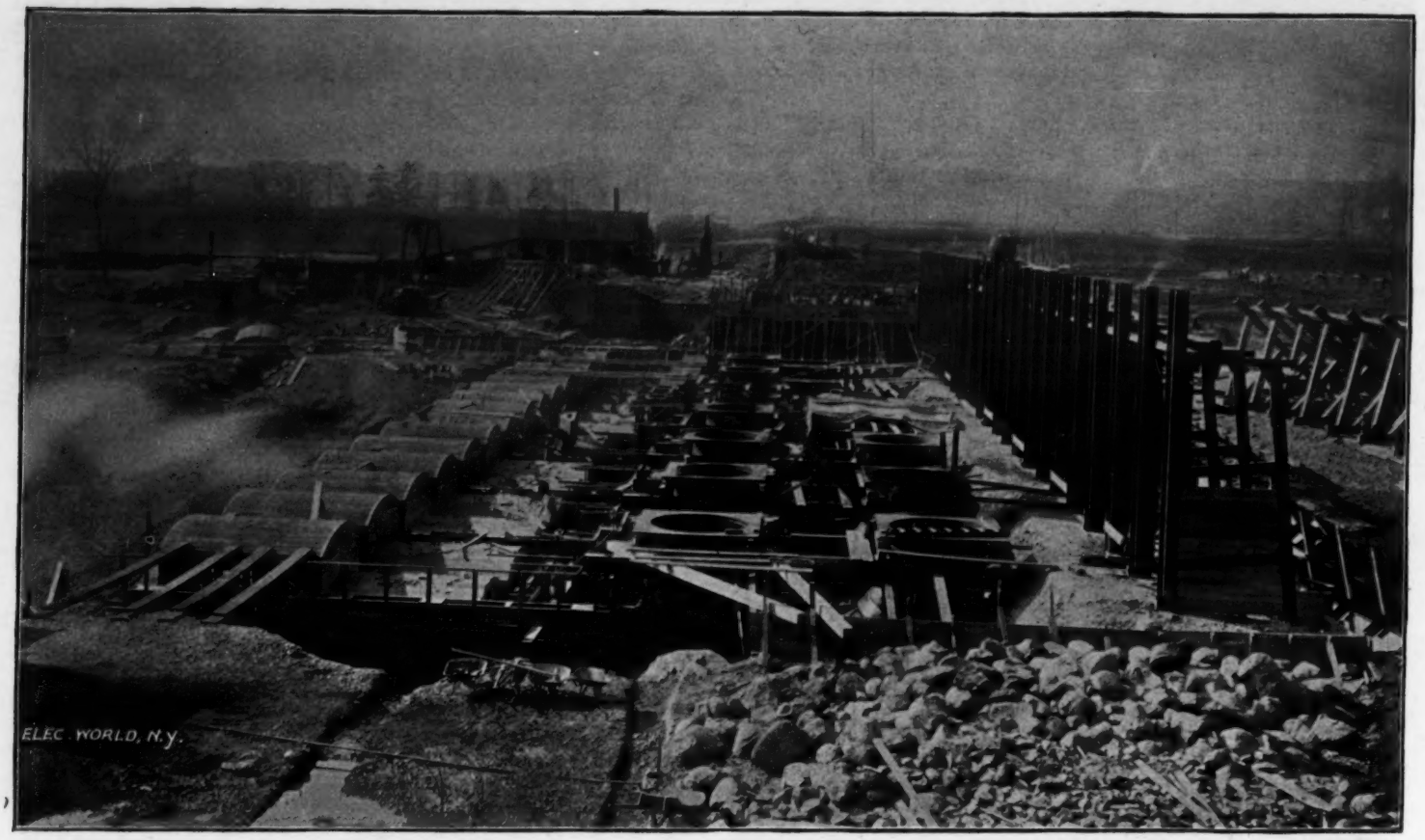
It melted at 285° Fahr., and was rather thick when melted. It solidified quickly, and showed the same physical properties that were noted before melting,

It alone could not be used as an insulation on account of its extreme hardness and brittleness, and only those mixtures were tested that seemed to promise satisfactory physical properties. Adding mineral wax in large proportions made the mixture very tough and flexible and the flow very marked. Sapho lowered the melting point, did not decrease the hardness and brittleness, and only slightly increased the flexibility and flow. Ozite lowered the melting point 60°, and only increased the flexibility and flow a very slight amount.

Mixtures of hard coal-tar pitch and ozite would not be satisfactory, on account of their brittleness.

Mixtures containing equal parts of hard coal-tar pitch and sapho would be fairly satisfactory where there was no danger of sudden blows.

Mixtures of hard coal-tar pitch and large proportions of mineral wax would be quite satisfactory, being very tough and flexible, and having a marked flow.



Race-Ways, Draft Tubes and Frame of Upper Step of Dam, Mechanicville.

The Mechanicville-Schenectady Power Transmission.

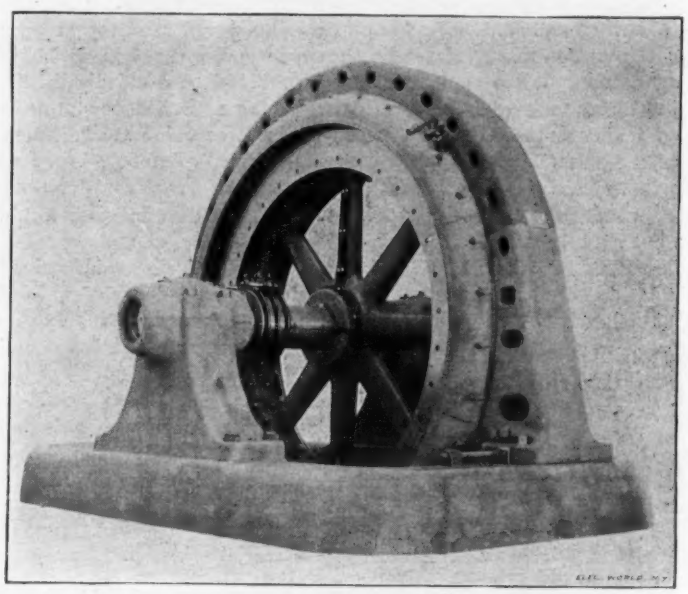
BY CHARLES P. STEINMETZ.

Some of the electrical features of the Mechanicville power station and the transmission to the General Electric Works at Schenectady may be of interest, as may be also the reasons why these features have been adopted, particularly as the manufacturer of the apparatus in this case is the largest customer, and his advice has been adopted in selecting the apparatus, thus ensuring them to be best suitable to the conditions.

The frequency selected for this plant is that best suited for all-around use, for lighting, synchronous and induction motors, and conversion to direct current. Thus the frequencies of 125 cycles and of 25 cycles were excluded, the one as too high for rotary converters and large induction motors, the other as unfit for lighting and less suitable for smaller motors. Hence the choice lay between the standard frequencies of 40 cycles and of 60 cycles. The former was adopted as somewhat better suitable for rotary converter work and for induction motors.

The generators to be installed at Mechanicville, of the type A. T. B. 40-750-120-12000, are 40 cycles untooth three-phase revolving field type, of 40 poles and 750-kw rating, similar to the machines operating the Lachine Rapids power transmission, but wound to generate directly 12,000 volts, so as to avoid the necessity of step-up transformers. The revolving field type was adopted in preference to the revolving armature type, since the stationary armature winding of the former allows the construction of a generator to produce directly the transmission voltage. The revolving field type was preferred to the inductor type, since the latter requires very high density in the magnetic structure, and thus gives a lesser margin in voltage and in speed than the revolving field type, which latter allows the use of fairly low saturation of the magnetic circuit, thus giving a nearly straight saturation curve. Such a saturation curve, while making the machine slightly inferior in regulation to the same machine with an over-saturated magnetic circuit, is preferable in power transmission. It allows a considerable increase of voltage when needed, for instance, to cover excessive drop in voltage in lines due to heavy loads, etc., and permits the voltage to be maintained, even if the speed is low, as in the case of high water, etc. The generators are arranged to be operated in parallel at constant voltage in the generating station.

At first 2,000 horse-power will be transmitted to the General Electric Company's factories at Schenectady over a line of about eighteen miles length, consisting of three wires of No. 000 B. & S. This large size of wire has been chosen in preference to the use of several small wires in multiple in order to give the line as high a self-induction as possible. While in the early days of power transmission self-induction in transmission lines was carefully avoided in

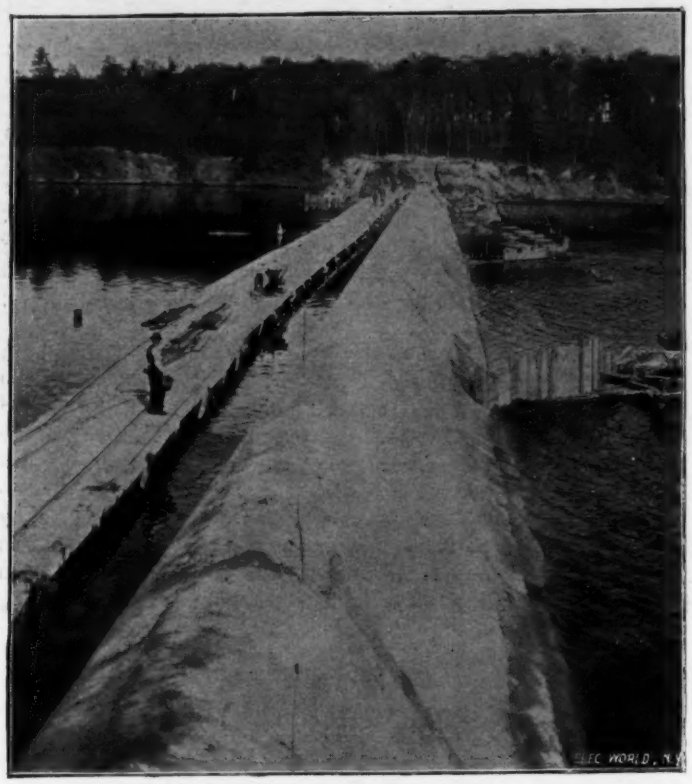


Type of Generator for Mechanicville.

transmissions, where a large part of the power is taken up by synchronizing apparatus, such as rotary converters and synchronous motors, a considerable amount of self-induction in the lines is now considered desirable. In fact, if the line has too small a self-induction, as when cables are used, it is intentionally inserted in the form of reactive coils. This is the case in the St. Anthony Falls power transmission, which is now being installed for operating the railroads of St. Paul and Minneapolis by a number of 600-kw rotary converters.

The receiving apparatus in Schenectady consist of two synchronous motors of 500 kilowatts and 100 kilowatts respectively for the testing department, and three rotary converters of 400 kilowatts for the operation of the factories. Air-blast transformers of the standard General Electric type are used for transforming the pressure.

At present the testing department is operated from an entirely separate power plant to secure complete independence in speed and voltage from the factory power plant. A large engine drives an M.



FINISHED CONCRETE DAM.

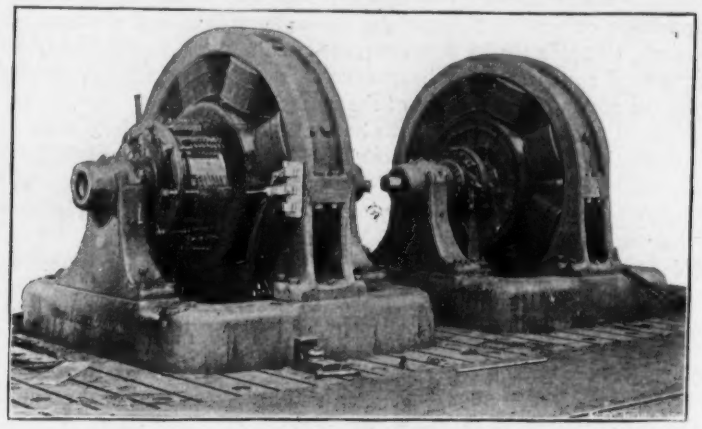
P.-4-500-375-550 railway generator, supplying power at 550 volts to the motors in the testing department, and a smaller engine drives a number of exciters to give independent and complete control of the excitation of all machines in the testing department. An A. P. B.-12-500-400-10,000, 12-polar synchronous motor of 500-kw rating and 400 revolutions, of revolving field type, and wound directly for 10,000 volts, will replace the engine now driving the railway generator supplying power at 550 volts to the motors in the testing department, while an A. P. B.-8-100-600-10,000, 8-polar synchronous motor of 100-kw rating and 600 revolutions, also of revolving field type, and wound for 10,000 volts, will drive the exciter plant. By this means the testing department is made entirely independent of all changes but the frequency, that is, the speed of the generators in Mechanicville, which will be kept constant, or will at least vary only very slowly, due to the large size of the station.

Synchronous motors were chosen in preference to induction motors. It is considered very undersirable ever to use an induction motor where a synchronous motor can be used, for the reasons which I have stated repeatedly, and which are: Synchronous motors do not produce lagging currents as induction motors always do, so that the question of power factor does not enter into consideration, but the phase displacement in the synchronous motor and its power factor can be made anything desired by controlling its field excitation. Synchronous motors are necessarily more constant in speed and more efficient than induction motors. When of the revolving-field type they are self-starting from rest with light load, and even with fairly heavy load, and also have an overload capacity, limited only by the heating of the motor. That is, any well designed synchronous motor will easily carry two or three, or even more, times its full load without dropping out of step for a time limited only by the heating of the motor, while induction motors, when built for such overloads, necessarily give at ordinary loads a very low power factor and poor efficiency.*

*I have never been able to drop a synchronous motor out of step by overload, but have succeeded in dropping a 75-kw synchronous motor out of step by a load of 140-kw when reducing the impressed voltage to one-half. Considering the output as proportional to the square of the impressed voltage, this would represent an overload of 7½ times full load.

In these synchronous motors the excitation will be constant, thus requiring no attention.

The three rotaries installed in the power-house will be of the double commutator type, T. C.-10-400-480-2 x 250, each containing two commutators and two sets of collector rings, fed from independent secondary coils of the same set of air-blast transformers. These two commutators connected in multiple give 250 volts for the operation of the factories, while when connected in series they give 500



EIGHT-POLE ROTARY TRANSFORMERS.

volts for testing. The reason of this is that the factories are operated at present by 250-volt motors, and it is considered undesirable to change these motors since the present steam plant will be retained as reserve, in case of a failure of the power from Mechanicville. For the operation of the factories the 250-volt circuit is very convenient, since it allows the operation of the lights from the same circuit by an Edison three-wire system.

The testing department, however, is operated by a 500-volt circuit, since this voltage is preferable for testing direct current machines. A very large part of the direct current apparatus, for instance, almost all railway machines, is built for 500 volts, and thus can be directly connected into the 500-volt circuit of the testing department.

While usually the testing department takes its power from a railway generator driven by the 500-kw synchronous motor above described, it is occasionally desirable and necessary to have a larger

RACE-WAYS AND POWER-HOUSE FRAMING.

power available, as for testing large generators, or heavy railway apparatus.

Therefore, when a larger amount of power is required for testing than can be given by the synchronous motor, it will be supplemented by the rotary converters. With their commutators connected in series for 500 volts, they can be operated in multiple with the railway

generator driven by the synchronous motor in the testing department, so that the total power is available as single unit.

All the rotaries will be operated in parallel, and all motors in the factories, the factory railway, the lights in the factory and office building will be operated from the same direct-current circuit; also the lights on the Edison three-wire system. To secure the neutral wire of the lighting system, the step-down transformers of the rotaries are connected in Y with their secondaries, and a lead brought from their common connection to the lighting neutral. Since the common connection or neutral point of the three-phase circuit of a rotary is neutral point also for its direct-current circuit, it can be used to feed the neutral conductor of a direct-current, three-wire system operated from the commutator brushes of the rotary.

In this transmission plant it has been considered desirable to secure extreme simplicity, and leave nothing whatever to hand regulation, but make the whole system self-regulating for constant voltage in the direct-current distribution system. For this purpose all the rotaries are supplied with shunt fields and with very powerful series fields, which are all joined together so that the rotaries in operation form one unit. The rheostats in the shunt and series fields will be set so that with constant voltage in the generating station at no load the counter E. M. F. of the rotaries as given by their shunt fields is below the impressed E. M. F., and a lagging current produced thereby. With such a lagging current the self-induction of the lines is in opposition to the voltage, and reduces the latter so as to give the desired voltage of 250 at the commutator brushes of the rotaries. With increasing load the counter E. M. F. of the rotaries rises rapidly, due to the series field, till at full load and overload it exceeds the impressed E. M. F., and the current is made leading. With a leading current, however, the E. M. F. of self-induction of the lines is brought partly in phase with their voltage, and thus increases it, so that in spite of the increased line current, and thus increased energy loss in the line, with constant generator voltage the same voltage is produced at the commutator brushes of the rotaries at full load and overload as at no load.

This control is perfectly automatic, and would be sufficient if the synchronous motors did not take power also over the same line in amounts varying independently of the load on the rotaries. To take care of this small series transformers will be inserted in the lines leading to the synchronous motors and feed a small synchronous motor generator, which controls the shunt fields of the rotaries, so that, independent of the load on the lines and the distribution of the load between the synchronous motors and the rotary converters, the voltage will automatically be maintained constant at the commutator brushes of the rotaries by the combined action of their shunt and series fields, leaving nothing for hand regulation except the readjustment of the rheostats in case of a change of the number of rotaries in operation.

It is expected that the plant will be in operation early next year.

The Electrical World of October 9, 1897, contained a brief description of the hydraulic work at Mechanicville, which was not completed at that time. The dam is now entirely finished, the National Contracting Company, which has a contract for all the work except the electrical equipment, having made a remarkable record for speed in its construction. No less than 7500 yards of concrete were laid in seven weeks, this including the time taken for pumping, building coffer dam, etc. In many respects the construction of this fine piece of hydraulic work is unique. The great speed of the work has been in no small part due to the systematic methods employed and the high class of engineering skill displayed. The officers of the contracting company, Messrs. G. M. Furman, general manager; E. A. Mathews, superintendent, and J. A. Leonard, constructing engineer, are to be congratulated upon the record for speed and excellence they have made in this important installation.

The United States at the Paris Exposition.

Major Moses P. Handy, Special Commissioner from the United States to the Paris Exposition of 1900, returned from Paris last Saturday. Major Handy succeeded in securing a concession of 200,000 square feet of space at the exhibition for the use of the United States exhibits. He states that the exhibition will probably be the grandest ever held, and that no country will be better represented there than the United States.

A Carbon Detector or Receiver for Hertz Waves.*

BY FREDERICK J. JERVIS SMITH.

Detectors of the Hertz electromagnetic oscillation (such as those of M. E. Branly, *Comptes Rendus*, 785, 1890) consist of small tubes, partly filled with metallic filings, furnished with pole pieces in contact with the filings. M. E. Branly, in his excellent paper, makes no mention of having tried carbon as a Hertz wave receiver. I find that receivers having carbon contacts have been spoken of as useless. Prof. Oliver Lodge, in his book—"The Work of Hertz"—mentions in a foot note (p. 30) that Professor Fitzgerald has succeeded with carbon, but no references are given to experiments on the point.

Thinking is possible that the smallness of the particles of carbon might affect the result, and that powdered carbon might not act in the same way as an ordinary microphone carbon which had been tried, I reduced some electric lamp carbon to the finest powder, and placed it in a thin glass tube furnished with terminals; the detector I thus made was placed in a circuit, including a dead-beat galvanometer (resistance 50 ohms), one dry cell, E. M. F., 1.4 volt, and about 8000 ohms added resistance.

When the circuit was closed, the carbon receiver having been previously tapped or gently shaken with a vibrating fork, the galvanometer indicated that a small current was flowing in the circuit. The carbon detector was exceedingly sensitive to the slightest electrical disturbance. To get the best result, the resistance of the carbon receiver should be such that a small current can flow through it. This condition is easily obtained by furnishing the carbon receiver with pointed terminals, which can be screwed to any required depth into the powdered carbon. On trying to set up the same conditions with a detector containing metallic filings (nickel, iron, copper, silver), difficulty was experienced in so adjusting the terminals that a small current should flow, but with carbon the difficulty entirely vanishes.

The carbon receiver proved itself to be a most interesting instrument. During a thunderstorm which took place within a few miles of Oxford on July 27, the galvanometer indicated that each flash slightly reduced the resistance of the carbon receiver, and the spot of light was shifted by successive jerks in the same direction till quite off the scale; the night being still, the gradually approaching storm could be well observed.

After the movement of the spot of light the time was taken with a stop chronograph watch, and after fifty seconds the thunder could just be heard, the lapse of time indicating a distance of over 10 miles. During forty minutes, the time between the indication of the carbon detector and hearing the thunder changed to ten seconds, which was the minimum time.

Some detectors similar in dimensions, but made so that they could be exhausted, were tried at the same time, the different detectors being thrown into the circuit by means of a switchboard; the vacuum does not appear to improve the action. The tubes were carefully made by the late Mr. E. Cetti, and exhausted in November, 1896. From these, and many other experiments, I believe that carbon, instead of being a useless substance as a detector of Hertz waves, will be found (when in fine powder) to be both reliable and certain in its action.

During the storm I have spoken of the apparatus was placed on a table in a room, the door and windows of which were closed. The instrument was not in connection either with the earth (except in as far as it rested on a deal table) or with any conductor extending into the air outside the house.

I have fixed a mast to the roof of the house, so that a conductor may be easily hauled up it; when the detector is connected to this and also to the earth, atmospheric electricity interferes considerably with telegraphy with a Branly or my powder carbon detector.

Electric Railway in the City of Mexico.

A dispatch from the City of Mexico, dated November 4, states that the syndicate in London controlling the street railway in Mexico, has instructed the manager to commence work equipping the line with electric power. It is stated that this will be the first railroad in Mexico to be operated on the electric system.

* From the *London Electrician*, October 22.

A Sierran Transmission Plant.*

BY GEO. P. LOW.

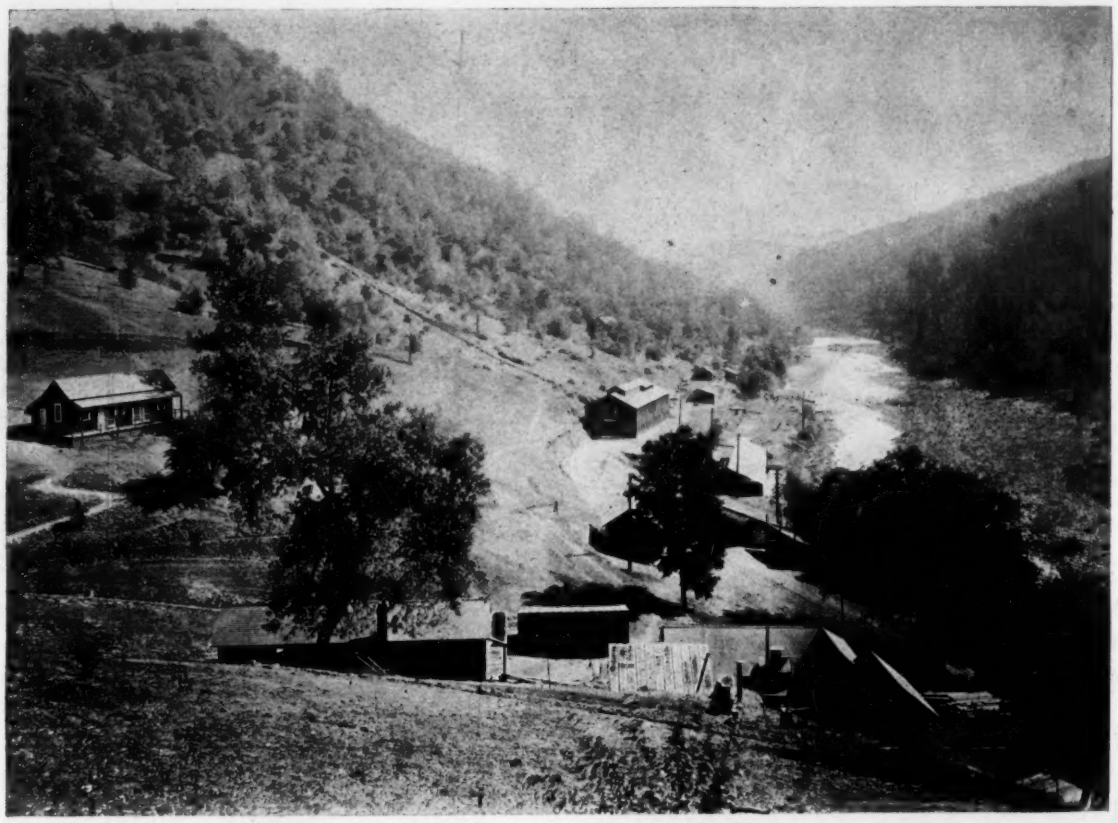
High in the Sierra Nevada range in Central California, almost directly east of Stockton, are the Blue Lakes. Their elevation above the sea level is some 8000 feet, only 1000 feet below the crest

A CHARACTERISTIC VIEW IN THE CATCHMENT AREA.

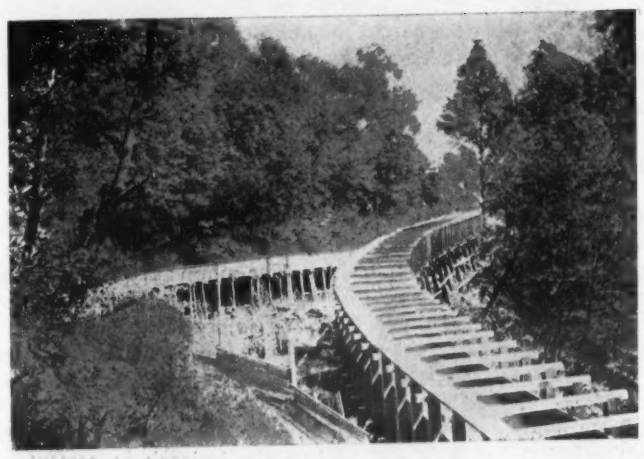
of the range. They drain a catchment area of several thousand acres, and are fed by great fields of snow and rushing torrents from the slopes above them.

The Blue Lakes Water Company was incorporated in 1890 to develop and distribute water-power for mining operations in Alpine, Amador and Calaveras counties and the neighborhood thereabouts. This part of the State is memorable for the mammoth hydraulic works that for many years tore away its hillsides, washed the earth through sluices and left a country of boulders and gulches similar to the moraines of glacial action. Plenty of gold, however, was left in the soil and the mother lode. This gold has never been obtainable because of the high cost of fuel, wood being cheaper than coal, and that at about $5 per cord. All that is needed for the development of many paying mines is power. This the Blue Lakes Water Company undertook to obtain from the streams flowing through the mountains. The company has a capital stock of $10,000,000, and is authorized to issue $5,000,000 in bonds. Of this amount $725,000 has been issued and $600,000 has been paid in for stock.

The company now owns all the available lands surrounding the lakes and reservoir and along the rivers, canals and ditches which it uses. Its main reservoirs are the Blue Lakes, high in the mountains, the storage capacity of which has been greatly increased by the building of dams. Upper Blue Lake has been confined by a masonry dam 250 feet long, 25 feet high and from 30 to 50 feet in width, giving the lake an area of 375 acres. Lower Blue Lake has also been enlarged by a crib-work dam with earth filling. The water from the lakes is discharged into Blue Creek whence it flows through various natural waterways for a distance of 40 miles, falling in that distance almost 6000 feet. Various auxiliary streams and storage ponds adjacent to the route are also tapped. The natural water ways used run through almost their whole course over solid granite, so that there is practically no loss of water from seepage and but little loss by evaporation, owing to the velocity of the stream and its consequently small surface. At a height of something over 2000 feet above sea level the water enters the Amador Canal. This artificial waterway is 42½ miles long, the first half being a flume running along the steep, rocky slopes of the main canon of the river. Eighteen miles below the head-gate the canal leaves the canon, passes through a short tunnel and enters a region of clay and gravel, through which it runs as a ditch to its terminus in the



GENERAL VIEW OF BLUE LAKES CITY.

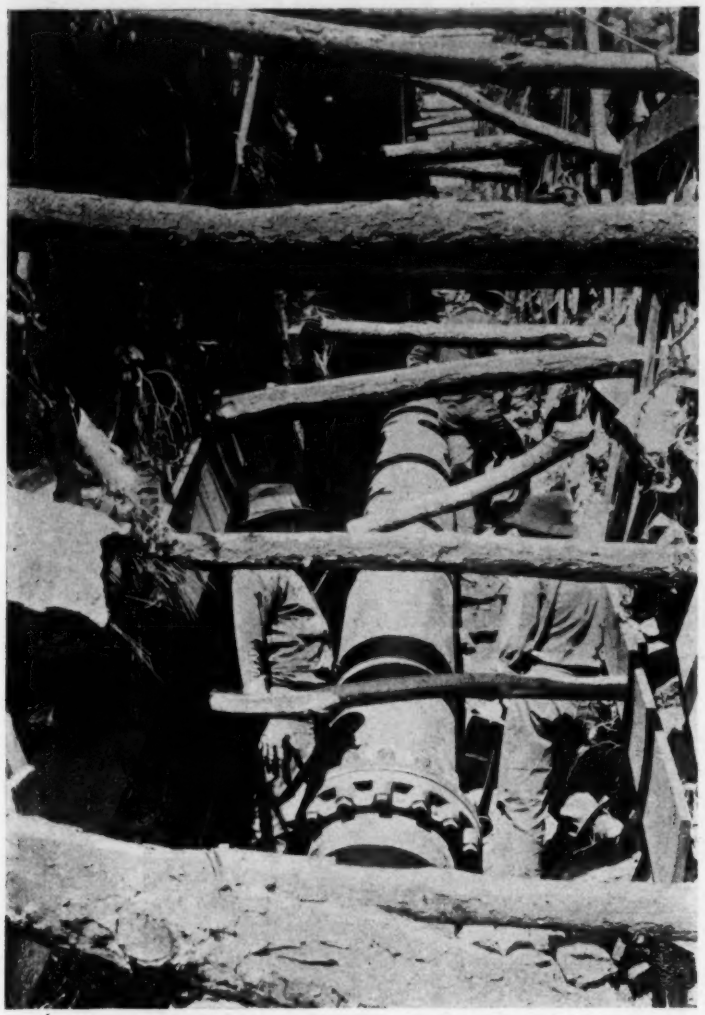


A FLUME ON THE AMADOR CANAL.

* Abstract of a paper in the *Journal of Electricity*, Oct., 1897.

Tanner reservoir. The canal has a grade of 8 feet per mile, giving an average velocity of flow of 300 feet per minute, which, when full, gives a capacity of about 3000 miner's inches of water.

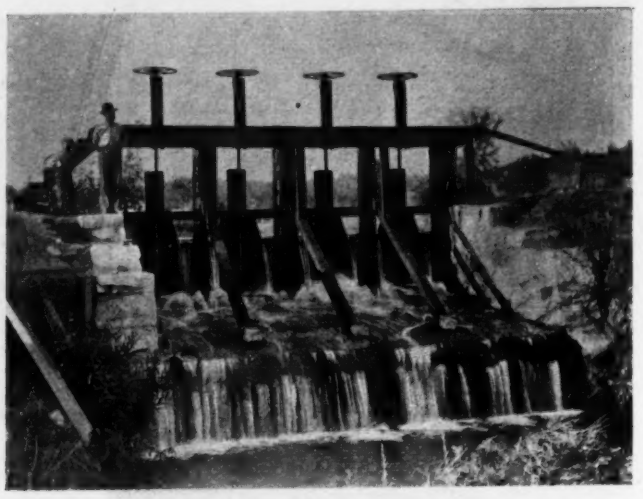
The water delivered through the canal is used for the general supply purposes of various towns and villages in the neighborhood of Blue Lakes City, as well as for the company's electric power plant and the operation of a number of mines. Near the lower end of the canal are several reservoirs, which, when improved, will contain sufficient water to supply the whole system continuously for over a week, if the canal should be totally out of service for that length of time. The ditch feeding the pipe line to the power plant ends in a massive concrete structure serving as a combined forebay



A Deep Cut on the Pipe Line Trench.

and settling basin, the whole construction being of the most durable type. Connected with this forebay is a spillway, which discharges waste water down a canon other than that used by the pipe line. The pipe-line supply is taken near the surface, and carried through double sets of strainers before entering the pipe. The pipe line itself is 3240 feet in length. In plan it follows an absolutely straight line down the surface of the rock from the penstock to the power house. The average slope is such as to give a head at the wheel nozzles of 1040 feet. The first 800 feet of the pipe line consists of a thin steel, slip-joint pipe; the next 900 feet of riveteed steel pipe, ranging in thickness from one-sixteenth to one-fourth of an inch, joined by cast-steel flanges. The final section of 1500 feet is made of lap-welded steel pipe, of a thickness of three-eighths to one-half an inch. Cast-iron socket flanges are used, packed with sheet-lead gaskets highly compressed. The inside diameter of the pipe line varies from 24 inches to 21 inches. The mountainside on which the pipe line is laid is covered with soil of varying thickness up to 25 feet. To prevent any possibility of injury from landslides, the pipe is laid on bedrock throughout its entire length, and cemented thereto. For 400 feet at the lower end of the pipe line, a trench was blasted out of solid rock, and the pipe was cemented in place with concrete filling. At each joint for about two-thirds of the distance up the hill the pipe is anchored to the bedrock in cement. The lower end of the pipe terminates in three cast-steel "Y" branches, which lead direct to the water wheels. The walls of these Ys are one-half inch thick.

The most important feature of the hydraulic system is the fact that there is no receiver or air chamber. The gates in the plant are so built that it is impossible to open or close the main gate in less than ten minutes' time; nor can any of the four nozzles be opened or



A Mountain Head-Gate.

closed in less than three minutes' time. It is believed that this arrangement will prevent any possibility of water ramming. The governing will be effected by hooding two of the four nozzles of each wheel, the remaining two being provided with manually operated throttle valves. The diversion of the stream from the wheels by a hood will, of course, make no difference in the discharge rate, so that there will be no water ram from that cause. At present the wheels are governed solely by hand.

The power house is a substantial building 35 x 100 feet in size,

Y-Branches at Foot of Pipe Line.

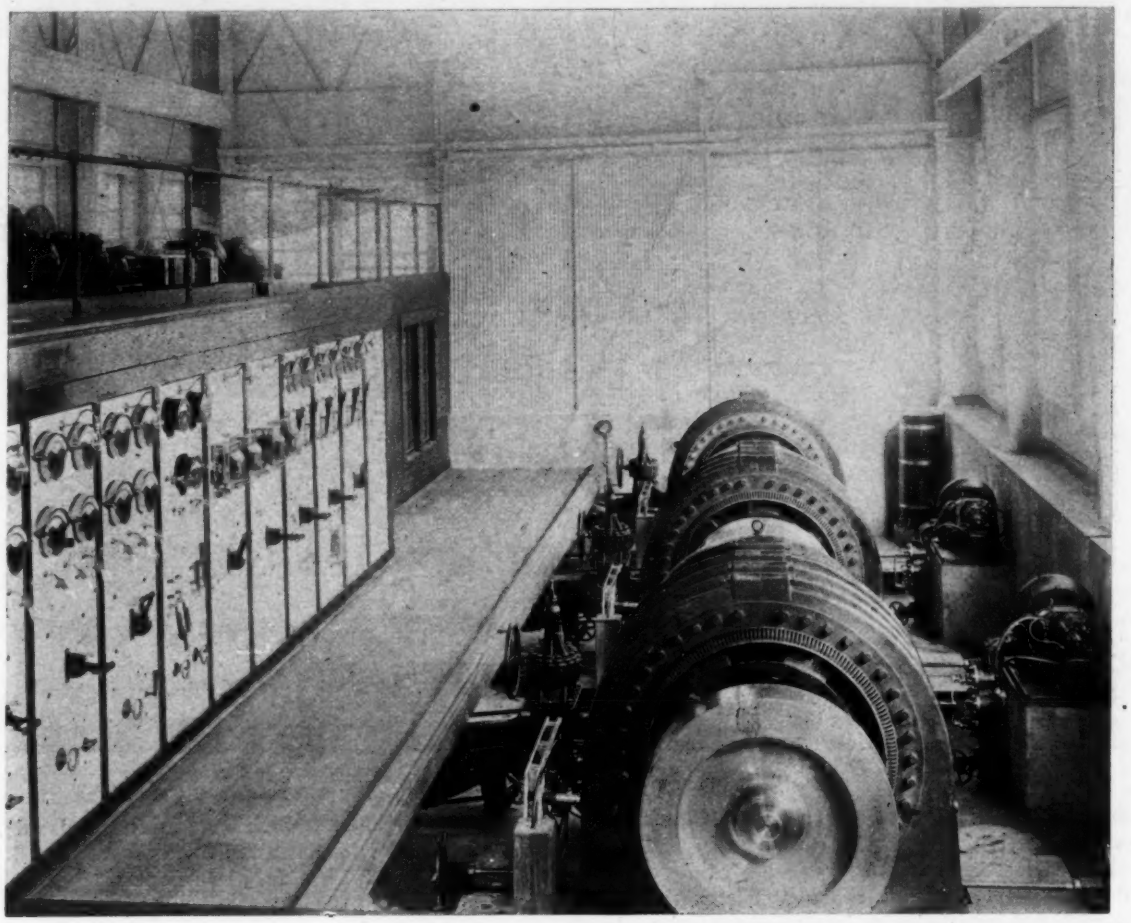
the present machinery only filling one-half of this space. The structure is longitudinally divided into two levels, the upper or switchboard level being 8½ feet above the floor level, on which is placed the main machinery. Part of the space for the building has been blasted out of solid granite, the stone so removed being used in the walls. The generator and water-wheel foundations rest on granite at a depth of 9 feet. The building proper is of steel-frame construction and covered in a rather peculiar way. Over the steel frame is stretched wire netting on all sides and the roof. This netting supports two layers of asbestos paper, over which are laid two layers of tarred paper, which is finally covered with heavy corrugated iron. The paper is intended to prevent condensation. A 10-ton traveling

crane traverses the whole of the generator room, which, being painted white, presents a pleasing appearance.

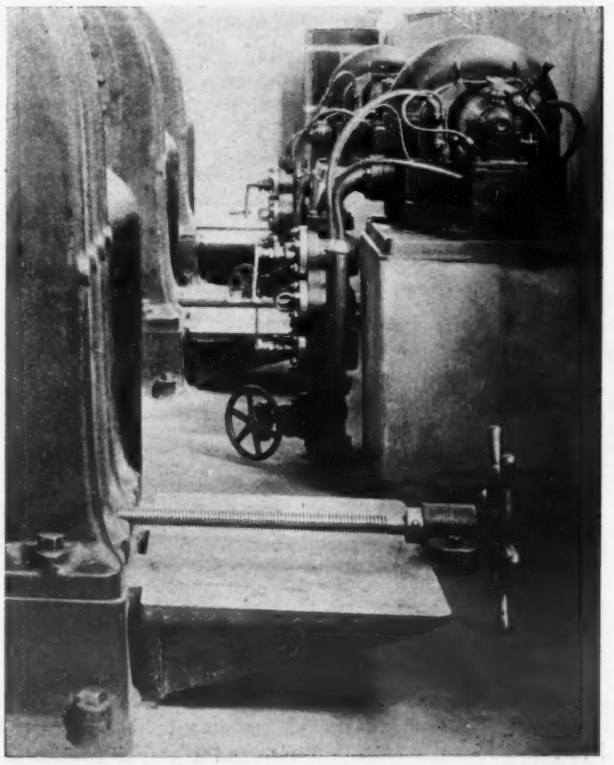
The water is led from the Y castings to the main gates of each of the three wheels through 15-inch pipes. Each gate is operated by a worm and worm wheel, the worm wheel being fixed to the nut on the valve stem. This gives such a speed reduction that it is impossible to move the valve rapidly. The worm wheel is inclosed in the pressure chamber, which eliminates the necessity of packing. The water wheels are of the impulse type, 4 feet in diameter, and were made by the Abner Doble Company, San Francisco. These wheels run at 600 revolutions per minute, and are rated at 700 horse-power each. They are incased in cast-iron housings of an exceptionally neat and simple appearance, as shown in the illustration. The wheels are direct-coupled to the generators, the end of the shaft on the other side of the generator carrying a 4000-pound fly-wheel. The shaft runs in two bearings only, the fly-wheel overhanging one end and the water wheel the other end, the armature being between the two bearings. The rotating parts of the generator weigh, all told, about 20,000 pounds, which gives considerable moment of inertia to help in the speed regulation.

The dynamos are 450-kw Stanley two-phase, inductor type machines, delivering current at a frequency of 60 cycles per second, at a potential of 2000 to 2400 volts. These generators being of the standard Stanley type, are too well known to require detailed description. Two exciter sets are provided, each consisting of an 18-inch Doble wheel direct-connected to a 10-hp dynamo. These are located on concrete piers to the rear of the generators. The jets of the small wheels working on this high head are of such a small diameter that there is risk of small chips of wood or twigs stopping them up. To provide for this the water delivered to them is passed through strainers made of brass gauze and mounted in cartridges which are easily removable. Two cartridges are provided, with a two-way valve, so that either may be used while the other is removed. The exciters generate current at a pressure of 60 volts, either exciter having a sufficient capacity for energizing the fields of all three of the main generators.

The main switchboard is provided with two sets of four-pole bus bars, each main generator switch being four-pole and double-throw, so that either generator can be worked singly or both in multiple, on either or both sets of bus bars. Power is delivered at present to two transmission lines, one of which is supplied by contract with the California Exploration Company. Two Thomson recording watt-meters are mounted on the switchboard, one of which measures the power delivered to this contract line and one to the line of the water company itself. The switchboard is fitted with ten panels, several of which are not in use as yet, but will come into use as the different transmission lines are added. One of these lines will extend to Stockton, 39 miles distant. The switchboard is fitted with synchronizing apparatus, consisting of the usual transformers, whose secondaries may be connected in series and thrown on lamps. The only part of the synchronizing equipment that appears on the front



THE INTERIOR OF THE POWER STATION.

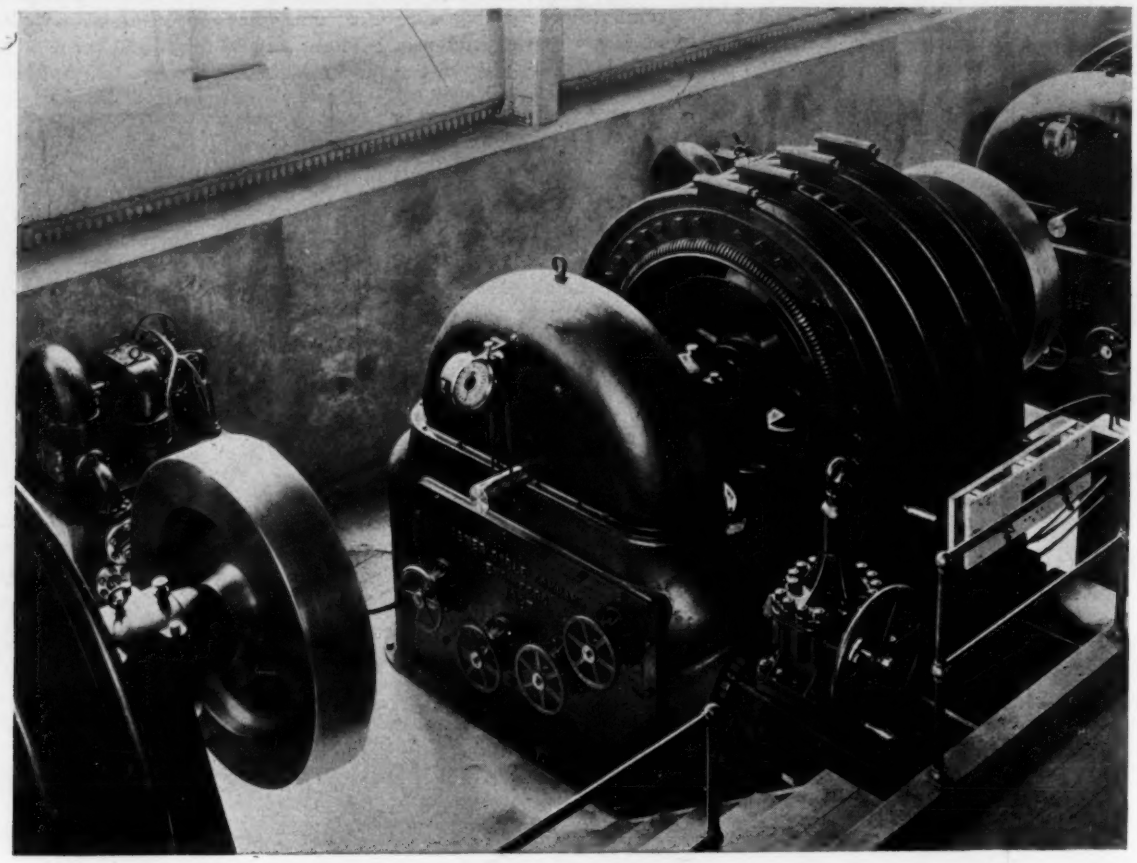


THE EXCITER SETS—SHOWING THE STRAINERS.

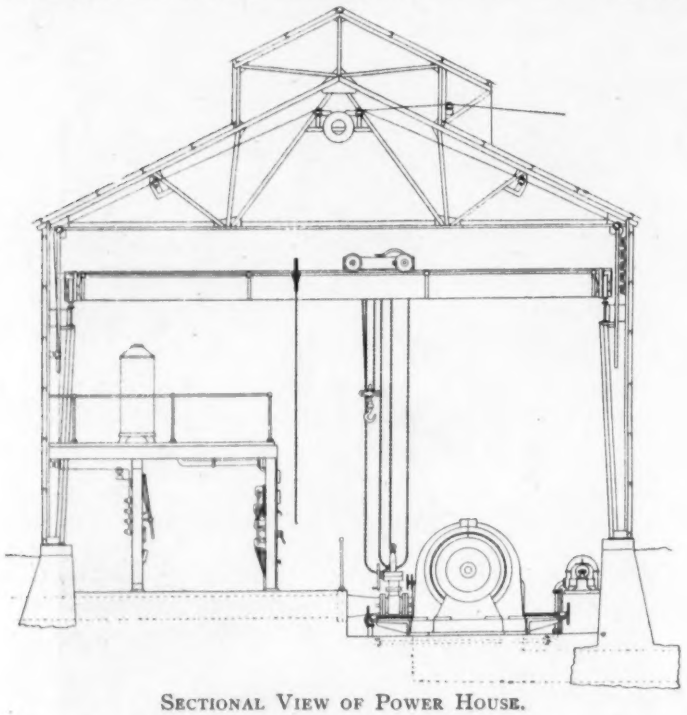
of the board is a small, U-shaped plug, by means of which the combinations of the secondaries of the synchronizing transformers are changed to indicate synchronism between any two of the three generators.

The voltage to be used on the circuits now erected is 11,000 volts, but the step-up transformers have not yet been installed, and a pressure of 2400 volts is delivered direct from the generators. Before spring, however, the high voltage will be put on the line. From the high-potential panels the line circuits are carried to choking coils beneath the roof frames. These choking coils are made by winding 200 feet of No. 3 insulated wire into coils measuring about 24 inches in diameter. Between them and the outside lines are the Wirt alternating-current, short-gap lightning arresters. Five of these arresters, which are designed for 2000 volts each, are connected in series between each line wire and a graphite resistance of 400 ohms, which is connected with the ground. The gap between the arrester cylinders is one-thirty-second of an inch. The design of the device is such that the arc is extinguished upon reversal of the current by the cooling effect of the large metal cylinders.

The pole lines carrying the transmission circuits are of the most substantial type. Thirty-five-foot selected red-wood poles are used, measuring 10 x 10 at the butt and 6 x 6 at the top, and sunk 6 feet in the ground. Two 22-inch cross arms are placed 18 inches apart, and at curves are doubled and framed together. All poles on curves are firmly guyed. Two No. 3 B. & S. gauge bare wires are placed on each cross arm, 18 inches apart, each phase being carried by the wires diagonally across the square. Locke triple-petticoat porcelain insulators are used. The lines are not transposed. Over the tops of the poles, supported on porcelain knobs and grounded at intervals, is run a close-barbed galvanized-iron fence wire for lightning protection. The line is run through a rugged country, so that the distance between poles varies from 50 feet to 125 feet. On nearly its entire length the pole holes were blasted in solid rock.



One of the Wheel and Generator Sets.



Sectional View of Power House.

Power has been supplied to various mines in the vicinity for some time by ditches branching from the main canal, and carrying water to the wheels at the mines themselves. As the elevation differs at the various mines, the power output per cubic foot of flow was a very variable quantity, and in case of high elevation no power could be delivered in this way. These local water wheels will now be replaced by motors deriving their power from generators in the main station. It is estimated that between 1500 and 2000 horse-power will shortly be used by the mines situated along the mother lode in Amador County. The cities of Jackson, Sutter Creek and Amador have heretofore been lighted from a central station located in Sutter Creek, driven by water from the canal. The lighting system has now been changed over and put on the 2400-volt generators direct, the load amounting to about 300 horse-power.

The power plants for utilizing the electric power in the mines have not as yet been installed. In some instances large induction or synchronous motors will be belted direct to the main shafts in place of the present water wheels, while in other instances, small units will be distributed throughout the works. It has been proposed to run steam engines where such are in place, as air motors fed by air compressed into receivers, consisting of the present steam boilers, by compressers run by two-phase motors. It is hardly likely, however, that anything will be gained by this multiplex transformation arrangement. The use of the two-phase motor in place of the steam engine would be far preferable, except possibly in instances where intermittent power for brief periods only is necessary.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES COMPILED FROM FOREIGN AND AMERICAN JOURNALS

BY

CARL HERING

DYNAMOS, MOTORS AND TRANSFORMERS.

Determining the Series Winding of a Compound Dynamo. FRY. Lond. *Elec. Rev.*, Oct 22.—He shows how to determine the series winding necessary to keep the potential constant, a problem which cannot be solved with absolute accuracy. The losses which are to be compensated are those due to the resistance of the armature and those due to its reaction; when the dynamo has been constructed he shows how to measure a certain factor which enables the armature reaction to be determined; in this case the relation between the E. M. F. and the number of ampere windings on the magnets is calculated with the aid of Froehlich's theory by means of which he obtains an equation with two constants which are then determined from experiments with the simple shunt wound machine with two different currents in the magnet coils. When it is to be determined by calculations alone he shows how this can be done by the formula of Dobrowolsky for the armature reaction.

Loss of Voltage in Alternators. FISCHER-HINNEN. *L'Eclairage Elec.*, Oct. 23.—A long, illustrated article which appears to be in substance similar to his recent one in German, which was noticed in the *Digest*, Oct. 30.

Parallel Running of Alternators. S. E. T. EWING. Lond. *Elec. Eng.*, Oct. 22.—An article discussing the subject from a practical view, describing the best conditions and methods for those who have charge of such work; most of it is already well understood.

Determining the Compounding Coils of a Dynamo. FLEISCHMANN. *Elek. Zeit.*, Oct. 28.—A short article describing a simple method for experimentally determining the series winding of a compound machine when the machine is so large that the constructor has not sufficient power to make the usual test at full load; the method is analogous to that of Kapp for testing alternators and transformers, and it is based on the fact that the loss of voltage in the armature and the armature reaction, are dependent on the current and not on the voltage, for which reason a short circulating current of the normal amount will act similarly as the same current at the full voltage. The dynamo is run at the normal speed and the armature is short-circuited through an ampere meter, the field magnets being excited sufficiently so that the armature current at short circuit is equal to the normal current at full load; from the exciting current and from the number of turns around the magnet, the ampere-turns necessary for compounding may be determined as follows: From the magnetization curve of the dynamo (that is, the curve giving the voltage for all the values of the ampere-turns) find the ampere-turns required to generate the voltage at short circuit, that is, the voltage in the test just described (see remarks below); substract this from the ampere-turns just determined by the test, and the difference will be the ampere-turns required to compensate for the armature reaction; from the magnetization curve find the ampere-turns for generating the full voltage of the machine at full load, that is, the normal voltage plus that lost in the armature resistance (calculated), and add this to the ampere-turns just determined for compensating for the armature reaction, the result will then be the total amperc-turns; these may then be increased slightly as the magnetic leakage will be greater for a high magnetization. (He is not very clear in his statements; by the voltage at short circuit, he no doubt means the voltage on opening the short circuit, but keeping the excitation the same.)

Electrical Engineering in Europe. ZAHN. *Elec. Eng.*, Nov. 4.—A brief description of the engines and dynamos made by a firm in Berlin, Germany.

Constructing Commutators. FELLS. *West. Elec.*, Nov. 6.—A brief, illustrated article describing the way in which he makes commutators, the bars of which are cast and assembled between shellacked mica separators.

LIGHTS AND LIGHTING.

Alternate Current Enclosed Arc Lamp.—Lond. *Elec.*, Oct. 29.—Some editorial notes on a recent test of a lamp invented by Davy and Davies, which lamp, it is said editorially, leaves no doubt that the practical difficulties have at last been overcome. A full description is promised and the following details of a test are given: It had two 13-mm cored carbons enclosed in a cylindrical opal glass globe; there was a choking coil in series, on a constant voltage circuit with a frequency of 50 and the voltage on the lamp itself was 77, or 68 across the arc, which exceeded one-half inch in length; the current was about 8.5 amperes and the watts 540; the candle-power in the horizontal plane was 356, corresponding to 1.51 watts per candle; at 45 degrees it was 420, corresponding to 1.28 watts per candle; the consumption of carbon was at the rate of about 3.62 mm per hour for the two carbons together.

Illumination of the Congressional Library Rotunda. HUTCHINSON. *Elec. Eng.*, Nov. 4.—An article describing the illumination of the interior of this rotunda with incandescent lights, and giving the results of some photometric tests in which the illumination by various combinations of the circuits were measured, the results being given in tables; the results suggest the conclusion that with fair diffusing surfaces the location of the light has little influence on its effectiveness in illuminating a given surface. It is generally assumed that the total light required in an enclosed space with broken surfaces is proportional to the volume of the space; assuming the average value from the table it follows that the watt per cubic foot required per candle-power per square foot was 0.02; the candle-power per cubic foot required per candle-power per square foot was 0.0065; 4.5 candle-power per square foot gives a brilliant illumination and requires 0.09 watts per cubic foot or 0.029 candle-power per cubic foot.

New Surgical Lamp. HICKMAN. Lond. *Lancet*; reprinted in the *Elec. Rev.* Nov. 3.—A brief, illustrated description of an incandescent lamp one inch in diameter made in the form of a circular ring with an opening through the centre, the back of the lamp being silvered; the operator looks through the whole from the rear side of the lamp; it is held in front of the eye in a frame somewhat resembling that for a pair of spectacles; the advantages claimed are lightness and rendering unnecessary the usual bracket lamp.

Two-hundred-and-twenty-Volt Lamps. SHEPARDSON. *El'ty*, Oct. 27.—A reprint of his recent paper read before the Northwestern Electrical Association.

POWER.

Steam Engine Governor. THUNDERBOLT system. Lond. *Elec. Rev.* and *Elec. Eng.*, Oct. 29.—An illustrated description of several electrically operated governors which are said to be ingenious and to have merit.

Steam Turbines at 200 Atmospheres.—Lond. *Elec.*, Oct. 29.—An abstract of the article noticed in the *Digest*, Nov. 6.

The Cities of the Future. MULLIN. *Cassier's Mag.*, Nov.—A short article in which he discusses briefly the effects of the utilization of water power and electrical transmission on the future development of cities. In former times there was nothing to be gained by leaving the country for the great cities, but the steam engines changed this; in the future the utilization of water powers with the aid of electrical transmission will produce another change. If, for instance, the total 7,000,000 horse-power of Niagara Falls could be distributed over an area with a radius of 40 miles, the district would be 233 times the size of Manhattan Island, and at half the density of the population in that island this would correspond to 58,000,000 persons; if the radius was 150 miles it would correspond to about two-thirds of the present population of the entire globe; while the modern industrial city depends upon its advantages with respect to coal, the future city will depend on the water falls.

Two-Phase Installation in France.—West. Elec., Nov. 6.—A brief, illustrated description from *La Nature* of the plant of the St. Ouenles Docks, where two-phase currents are generated and transmitted to a passenger station in Paris, where they are distributed as continuous currents.

Electric Pumps for Boilers.—West. Elec., Nov. 6.—A translation in abstract of the recent article by Simon, noticed in the *Digest*, Nov. 6.

TRACTION.

Accumulator Traction in Cologne. BIGGS. Lond. *Elec. Eng.*, Oct. 29.—A brief description of an experiment in which accumulator cars are to replace steam locomotives on one of the most frequented suburban lines about 6 miles long, on which three trips a day will be made. The weight of the car, which is an old one, is 12,000 kilograms, without accumulators or passengers; it will carry fifty-one persons; there are two motors taking up to 70 amperes for starting at full load; there are forty-six accumulators, weighing 5500 kilograms, for the plates of which granulated pumice stone is used; the capacity suffices for two journeys (whether return trips is not stated); the charging will be done without moving the accumulators; the car ran quickly and smoothly throughout.

Narrow Gauge Portable Electric Railway System.—Lond. *Elec. Eng.*, Oct. 29.—A well-illustrated description of the Koppel system of narrow-gauge tracks and locomotives for pioneer or temporary lines used by contractors, which is said to be cheaper than the ordinary construction. The trolley wire is held by arched iron carriers held by one of the sleepers; these are placed about 25 yards apart; illustrations of several of the locomotives are shown; the gauges are from 20 inches upwards and the locomotives are designed for 110 volts.

Electric Launch.—Lond. *Engineering*, Oct. 29.—A brief, well-illustrated description of one built in Holland; it is 52.5 feet long, has a 25-hp motor, 80 cells of accumulators which will give 30 effective horse-power for one hour with a motor having an efficiency of 82 per cent.; the speed is 11.8 miles per hour; the motor weighs 2100 pounds; for slow speeds the two halves of the battery are connected in parallel and the motor then runs 7.5 hours at a speed of 7.5 miles per hour; the thrust of the propeller is taken on ball bearings.

Engines for Electric Traction. Raworth. Lond. *Elec. Rev.* Oct. 29.—An unfavorable criticism of the recent article by Emery, noticed in the *Digest* Oct. 23.

Electric Towage on Canals.—Lond. *Engineering*, Oct. 22.—The conclusion of the long serial article (see *Digest*, Oct. 23). An illustrated description of the improved form of the Bovet apparatus is given, as it was used on the St. Denis canal; it is for chain haulage in which the friction is produced magnetically and the motor is driven electrically, the energy being obtained from a trolley wire; working drawings are given.

Electricity on Steam Suburban Railroads. Short. *Elec. Eng.*, Oct. 28.—A brief review and discussion of the recent paper by Heft; it is, to some extent, a brief review of that paper, which he considers a most convincing argument in favor of the substitution of electric for steam traction. The good results are undoubtedly due to the frequent train service, the freedom from smoke, the low fare and the high speed; the acceleration could be improved by the use of larger motors; he approves of the suggestion to use open motors for this class of work to ensure perfect ventilation, as the only part which really requires a cover is the commutator; by leaving the motor uncovered it would do fully 20 per cent. more work; he recommends transmitting the energy by high-pressure alternating currents and rotary transformers.

Constructing 2.5 Miles of Railroad in Twenty-two Hours.—Elec. Eng., Nov. 4.—A brief account of this recent achievement in constructing an electric railroad between Bound Brook and Somerville, N. J.; it was done to prevent another company stopping the work by an injunction.

Electric Cable Ways. Lamb. *Elec. Eng.*, Nov. 4.—A long, illustrated abstract of his recent Institute paper.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Manchester.—Lond. *Elec. Rev.*, *Elec. Eng.* and *Elec.*, Oct. 29.—A reprint, in abstract in the latter journal, of the report of a special deputation upon the result of inspections of Continental stations. The deputation was greatly impressed in favor of the Continental methods; it expresses a good opinion on the trolley system, and recommends its use in Manchester.

Reading, Eng.—Lond. *Elec. Rev.*, Oct. 22.—A brief illustrated description of this alternating-current plant, in which transformer sub-stations are used.

Meters vs. Flat Rates. Schuchardt. *Elec. Eng.*, Oct. 28.—A short article advocating the use of meters in place of flat rates; he recommends making the change in the spring, and at the start to make the meters read 10 per cent. slow for the larger consumers; the flat-rate system, he claims, is unjust both to the central station and to the consumer.

Municipal Ownership. Foote. *Elec. Eng.*, Nov. 4.—A reprint of a very long paper read before the League of American Municipalities on the "Cost of Service to Users and Taxpayers." He endeavors to point out a proper basis for comparisons between private and municipal ownership of water, gas and lighting plants; some agreement is necessary as to the cost and the method of obtaining it, after which theories can be tested by facts. An editorial states that the paper deals with the aims of the United States Department of Labor.

Chicago.—West. Elec., Nov. 6.—A very brief illustrated description of one of the smaller stations, which has recently been remodeled; it contains two-phase alternators, a 500-volt direct-current generator and some series arc-light machines.

Bradford.—West. Elec., Nov. 6.—A reprint of the descriptive article noticed in the *Digest*, Oct. 30.

ELECTRO-PHYSICS AND MAGNETISM.

Ferro-magnetic Properties of Iron and Steel. Fleming. Lond. *Elec.*, Oct. 22 and 29.—A reprint of a recent lecture to a society of engineers and metallurgists. It is written in an interesting style, the first portion being a brief summary of the subject of magnetism and is therefore somewhat elementary in character. In defining the terms dia-magnetic and para-magnetic he appears to limit the latter to bodies which are only very feebly magnetic, using the term ferro-magnetic in referring to iron, steel, nickel and cobalt; he uses the term weber for the unit of magnetic flux, but for the other magnetic quantities no names for the units are used; he describes how the flux is measured in practice and shows a set of magnetization curves for different temperatures; also some curves showing the variation of the hysteresis with temperature which were determined by Morris. He then offers an interesting explanation of the chief facts concerning ferro-magnetism; each little part of such a body is a complete magnet, showing that such bodies are built up of molecular magnets; moreover it is the molecule and not the atom which is the magnetic unit, a fact which is shown by the non-magnetic steels such as the Hadfield manganese steel, which, although it has 88 per cent. of iron, has a permeability of only 1.3 to 1.4; in unmagnetized iron the molecular magnets group themselves in closed circuits and magnetization consists in breaking up these circuits and forming larger ones; to explain the peculiar magnetic change in iron at the critical temperature the idea of molecular magnetization is not sufficient; he therefore takes as a starting point the accepted fact that atoms of all bodies carry electric charges and that the charge carried by a monovalent element such as a hydrogen atom is a sort of natural unit of electric quantity; his hypothesis of ferro-magnetism is that nothing more is required to explain the properties of iron than an assumption of rotation in a molecule built up of electrically charged atoms arranged in a peculiar way; with this warrantable assumption he gives a concordant explanation of all the main facts of magnetism and then proceeds to inquire if this hypothesis fits the facts and theories, finding ample support and encouragement; he hopes that this will serve to stimulate further investigation. In the second portion he makes some calculations concerning the size, number and charge of molecules, and the magnetic effect produced by their rotation. He assumes as the probable number of molecules in a cb. cm of oxygen at 0° C. and 760 mm is ten million million million, and that the diameter of a molecule is one ten-millionth of a cm; relatively this is like a cubical box of 500 miles to the side, filled with cricket balls; the absolute mass of a molecule is discussed and from this data he determines the probable magnitude of the absolute atomic electric charges. For metallic iron he obtains the probable magnitudes as follows: The number of molecules per cb. cm 10 to the 22d power; the probable diameter one ten-millionth of a cm; for the electrostatic charge on the iron atom six divided by ten to the ninth power, electrostratic units. He then develops his hypothesis, based on the experimental fact that an electrified body in motion is equivalent to an electric current and produces a magnetic field; an atom carrying a charge revolving in a circle around the centre will therefore create a magnetic field like that of a very short magnet; he applies this to a not improbable structure of iron molecules, showing that in some cases there would not be any magnet effect, while in others there would be; he considers, for instance, that a molecule consisted of four atoms, two with positive and two with negative charges, and that they may be represented as being situated at the corners of a square which revolves on the diagonal, through the two negative atoms; the centrifugal forces are calculated; these must be equaled by the electrostatic attraction; in this way he finds the magnetic moment for a cb. cm of iron magnetized to saturation and obtains 1000 C. G. S. units, while as a matter of fact it is really about 1500 to 1700.

Theory of the Induction Coil. Walter. Lond. *Elec. Rev.*, Oct. 22.—The beginning of a translation in abstract of his recent article in the *Wied. Ann.*, 62, p. 300. He works out a mathematical theory in a very much simplified form and verifies the results by experiments, finding them sufficiently exact for practical purposes. Discussing first the function of the condenser, he shows that the usual assumption is not correct, namely, that it is to absorb the current in the primary when that circuit is broken and thereby prevent the spark, as it is known that a condenser may be made too large; he shows how the length of the spark may be affected by the size of the condenser and gives the curve of the results, which shows the relation between the spark length and the capacity; the former increases very rapidly up to a certain point, then very slowly reaching a maximum and then falling off gradually and regularly; he explains this bend in the curve by the existence of oscillations in the primary circuit, a theory which he verifies experimentally. He discusses the primary circuit analytically, deducing a simple equation for calculating how long the circuit must be closed in order that the current may reach a given value. The important points established by his investigations are said to be that for every voltage within certain limits there is a certain speed of the break which will give the maximum spark length; a coil for four volts may be worked from 100 volts if the speed of the break is sufficiently increased, the voltage generated in the secondary being the same in each case, differing only in the number of sparks per second. He shows analytically what takes place in the primary circuit immediately after the break; regular oscillations arise for the periodic time of which he gives a formula which shows that it is not influenced either by the resistance or the presence of a break spark, a conclusion which was confirmed experimentally; the expression shows that the oscillations are damped. He then gives experimental evidence of the oscillations indicated by his theory, using the Braun apparatus.

In a more brief abstract in the Lond. *Elec.*, Oct. 29, it is stated that generally speaking it may be assumed that the magnetic value of the E. M. F. is strictly proportional to the maximum primary current and to the square root of the inductance of the secondary coil, and inversely proportional to

the square root of the capacity of the primary condenser. A crucial experiment showed that the spark length is strictly proportional to the maximum value of the primary current; if this is generally true the voltage corresponding to a 1 m spark would be 650,000, and to a lightning flash 200 m in length, 130,000,000.

Refraction and Conductivity of Wood. MAZZOTTO. *Rand. dei Lincei*, No. 6, 2, 5; abstracted in the Lond. *Elec.* Oct. 29.—Three articles, in the first of which he determines the electric refractive indices of wood, obtaining some interesting conclusions by a simple and sure method, the results agreeing well with those previously obtained. In the second he examined the effect of Maxwell's equation for wood and obtained a substantial confirmation of the law. In the third he describes the measurement of the conductivity of deal.

Electrical Properties of Fumes. KELVIN and MACLEAN. Lond. *Elec. Eng.*, Oct. 22.—An abstract of a recent paper from the Proc. Royal Soc. of Edinburgh. They studied the electrical properties of fumes from flames and burning charcoal, using three different methods; potentials were observed varying from 0.27 volt with the Bunsen burner to 2.03 with electrometer matches; charcoal and coal gave negative electrification when burning with a flame and positive when glowing without a flame.

Electric Earth Currents. COTTRELL. Lond. *Elec. Rev.*, Oct. 22.—The first part of an article in which he offers some suggestions as to the probable cause of earth currents which are manifested in grounded telegraphic lines. After giving the properties of these currents he reviews briefly and in an elementary way the various methods of producing electric currents, after which he intends to consider in what way the earth may in its relation to some celestial body be subject to electromagnetic actions.

Electric Endosmose. VILLEMONTEE. *L'Eclairage Elec.*, Oct. 16 and 23.—The continuation of his serial (see *Digest*, Oct. 30); he describes, with the aid of illustrations, the Grotthus and the Hittorf theories; in the latter portion he discusses electrolysis and osmose.

Localization by Röntgen Rays. DAVIDSON and HEDLEY. Lond. *Lancet*, abstracted in the Lond. *Elec. Eng.*, Oct. 22.—They describe an accurate method of localizing embedded objects which are seen by means of Röntgen rays. Two wires are placed across the plate at right angles and the tube is placed at a measured distance from these in a position exactly perpendicular to the plate over the point where the wires cross; the tube is then displaced to a measured distance to one side and another exposure made, the resulting negative showing double images; after development silk threads are stretched to correspond with the rays; the point where two rays in the two different exposures cross marks the position of the actual object.

Transparency of Vapors to X-Rays. VAN AUBEL. *Jour. de Physique*, Oct.; abstracted briefly in *L'Eclairage Elec.*, Oct. 16.—He measured the transparency of vapors and found that while liquid bromine was absolutely opaque the vapor was extremely transparent, thereby showing the great transparency of the vapors and the important part taken by the physical state in the transparency of bodies for X-rays.

Electrical Discharges. TROWBRIDGE. *Elec. Eng.*, Oct. 28.—A very brief abstract of a recent paper read before the American Academy of Science on the "Energy Conditions Necessary to Produce Röntgen Rays." Experiments show that the discharge in the tube when the production of X-rays is most intense is an oscillatory one, and that each discharge encounters a resistance of less than five ohms; assuming that Ohm's law holds for individual oscillations, the amount of energy can be estimated; but it appears from his experiments that Ohm's law does not hold, as a discharge of six inches encounters no more resistance than one of two inches; it can be maintained that a lightning discharge a mile in length encounters no more resistance than one of a foot in length; Ohm's law does not hold good for electric discharges in air and rarefied gases; he believes the oscillations are of the nature of arcs, as are also the discharges in a Crookes tube; under high electrical stress the ether breaks down and becomes a good conductor.

Röntgen Rays. *Elty*, Nov 3.—A reprint of the article from the Lond. *Elec. Rev.*, noticed in the *Digest*, Oct. 30.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrical Energy by Direct Atmospheric Action. WARREN. *Chemical News*, Oct. 22.—A short article giving the principles of a new battery which he says is operating successfully; he claims that it promises to be a liberal source of electricity on account of the "extremely low rate of the chemicals employed," and because it ranks next to perpetual motion on account of the perfect resuscitation; also because the expense is trifling. The positive element is compressed porous graphite, one-quarter of the plate being platinized with platinum black; when this is in contact with a solution of ferrous sulphate it induces the oxygen of the atmosphere to combine with it, producing a ferric salt; the negative plate is amalgamated zinc; the platinized portions of the carbons are above the solution, which latter consists of "a strongly acidified portion of ferric sulphate;" the current continues until the ferric salt is completely reduced; on withdrawing the zinc which is in the porous cup (the solution in this cup is not described), "an exactly reverse action is observed;" the platinized surface condenses the atmospheric oxygen, which reoxidizes the ferrous salt, and thus renews the action; with 4 ounces of ferric salt in a battery 7 x 5 inches the current is said to be 8 amperes at 2 volts for twenty-four hours, with but a slight drop. He hopes to be able to replace platinum with manganese compounds. (The article is (justly) ridiculed in the Lond. *Elec.*, Oct. 29.)

Concentration and Electrolysis. KOHLRAUSCH. *Wied. Ann.*, No. 10; abstracted in the Lond. *Elec. Eng.*, Oct. 29.—He deals fully with a variety of problems concerning the effect of electrolysis upon single and mixed solutions from a theoretical point of view, and works out some conclusions which may serve as a framework for the future complete theory.

Electrolyzer. RHODIN system. Lond. *Elec. Rev.* and *Elec.*, Oct. 29.—An illustrated description, more complete in the former journal, of a new system which is said to be well spoken of by various experts. Among the advantages claimed are that there is only a single chamber; that the apparatus is cheap, gives far better results than others, enables heat to be applied which increases the output greatly, has no pumps, involves no loss of mercury, etc.; it is for use not only for the extraction of metals or the electrolysis of alkalies, but also for the production of a number of other chemicals; the percentage of chlorine has been raised to 37 per cent. The outside cell is an iron dish, inside of which there is an inverted earthenware pot, the edges of which dip down below the surface of the mercury in the bottom of the iron dish; the inverted vessel contains a large number of carbon electrodes and is mounted so it can be revolved, the chlorine gas generated under it being led off by a tube; the mercury takes up the sodium, and the amalgam thus formed is caused to circulate by the rotation, thus passing to the outside of the earthenware vessel, where there is pure water over the mercury, which takes up the sodium, forming soda; the iron dish is heated to nearly the temperature of the boiling point, which not only prevents the absorption of a large amount of chlorine, but also increases the efficiency of the water in dissolving the sodium; the efficiency is claimed to exceed 93 per cent. of the theoretical output; there is practically no loss of mercury; the soda can be raised to a density of about 30 per cent.

Accumulator Construction. FITZGERALD. Lond. *Elec. Eng.*, Oct. 22.—The continuation of his serial. He shows that there is no probability of using any other metal for the peroxide plate; carbon will not answer but it can be used for the support in the lead plate where copper can also be used, but the battery cannot then safely be left idle for many days; there will be no trouble if the battery is prevented from running down completely; another material would be an alloy of aluminum and tin; their first cost is not a drawback; he considers the lithanode (solid peroxide) plate with platinum conductors "the most perfect known form of the lead accumulator;" (he is the inventor of such a battery). The densities of the active materials are enumerated. In the issue of Oct. 29 he discusses the Planté process of formation, describing what takes place. (As this series of articles promises to be quite long and as it is in the nature of a treatise on the subject, it will hereafter be referred to only briefly. Those particularly in this subject are referred to the original; it appears to be well written and shows that the author has made quite an extended study of the subject.)

Calcium Carbide Works Near Geneva. GUYE. *Prog. Age*, Oct. 15.—A brief abstract of the descriptive article which was abstracted in the *Digest*, June 5.

Tank Residues in Copper Refineries. KELLER. *Eng. and Min. Jour.*, Oct. 30.—An abstract of a recent article from the *Journal of the Amer. Chem. Soc.*, 19, No. 10; it gives partial analyses of the residues from copper derived from the ores of Butte, Mont., and the composition of the corresponding anode copper.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Resistance of Reostene. VAN AUBEL. *Jour. de Physique*, Oct.; abstracted briefly in *L'Eclairage Elec.*, Oct. 16.—He made determinations of the specific resistance of this material, which is an alloy of steel and nickel discovered by Glover, the composition of which, however, is not known; it is easily brazed and soldered and its density is 7.8991. The specific resistance at 0.44° C. was 77.07 microhm-centimeters; the temperature coefficient is given for various ranges and is about + 0.001; the resistivity is therefore greater than that of German silver, manganine or constantan, and much greater than that of either iron or nickel; its temperature coefficient is also greater than that of these alloys and is practically constant between 0 and 74°.

Localizing Faults in Submarine Cables. SCHAEFFER. Lond. *Elec.*, Oct. 29.—A long article describing some modifications in the null method bridge measurements. He discusses the loss of current test, for which the Weston instruments are well fitted, and shows how the disturbing elements may be removed; also a better way of correcting for the earth currents; a method of determining the absolute calibration of the instruments is also described. The method does not admit of being abstracted.

Location of a Break in a Cable.—Lond. *Elec. Rev.*, Oct. 22.—A short editorial article reviewing and criticising the recent one by Schaeffer (see *Digest*, Oct. 30). While it is believed that Kennelly's rule may be superseded by a more useful expression, it it is not thought to be demonstrated that Schaeffer has found it; it is thought there is a looseness of language which often is accompanied by a looseness of thought.

Determining Alternating Current Curves. Kubler. *Elek. Zeit.*, Oct. 21.—A short, illustrated article describing a simple and interesting improvement in the well-known Joubert method. The original method is well understood and appears to be an easy one, yet those who have used it know that there are a great many difficulties to be overcome; when the method is carried out with commercial instruments the sparks at the contact disc are quite great, so that at high voltages reliance can no longer be placed on the results. This difficulty is overcome by his simple improvement; it consists in attaching to the shaft of the alternator or synchronous motor, instead of the usual insulated disk, a cylindrical contact on which two brushes slide, these brushes being connected to the galvanometer or volt meter, thereby short circuiting it; the volt meter is furthermore connected, through a suitable resistance, to the circuit of which the current curve is to be determined; this cylindrical contact is broken by a longitudinal slit filled with an insulating material, so that in every revolution the brushes are insulated from each other for a moment and the short circuit of the instrument is therefore momentarily removed; the current then passes through the instrument and as these interruptions are frequent a constant deflection will be produced; by moving the brushes around the circumference of this contact in the usual way, successive points on the curves may be determined. To calibrate the apparatus all that is required is to connect it while running, with a source of continuous current of which the voltage is measured with another instrument. The chief advantage of this improvement is that voltages as high as one desires may be measured, as the break in the circuit is only a break of the short circuit around the instrument, and therefore there is no spark; for safety, one pole of the instrument should be grounded.

Theory and Application of the Phase Meter. Teichmueller. *Elek. Zeit.*, Oct. 21 and 28.—The conclusion of his long serial, (see *Digest*, Oct. 23). He discusses at length the dependence of the deflection upon the frequency of the current and concludes that it is great and too complicated to be corrected by calculation; moreover it is different for different kinds of instruments; this must be considered as a very grave fault of the instrument. He then discusses its application to measurements with a constant frequency and variable phase shifting, and shows that in general the phase meter cannot be used, it being applicable only for curves which approach the sine form and when the phase shifting is small. He then discusses its application for the comparison of self-induction coefficients and time constants, in the form of a zero method and concludes that in this application it loses all its faults, retaining all its advantages, therefore being a very convenient zero method for measuring self-induction coefficients; such a measurement is also independent of the frequency; he dwells on this at some length and suggests further investigation on this application; experiments should be made on coils with iron; it might also be used in the same way for measuring capacities; possibly also for investigating the properties of dielectrics for different voltages and curves of different forms; he also suggests that it might be used to great advantage for measuring the effective capacity of lines such as are used for telephony, thus determining one of the factors in Preece's law; he thinks the instrument well adapted for this purpose; he includes under effective capacity all that which causes a change of form of the current curve; he intends to make investigations in this direction and if successful he believes that this instrument should be classed among the most useful.

Specifications for the Cadmium Standard Cell. Jaeger. *Elek. Zeit.*, Oct. 21; translated in the Lond. *Elec.*, Oct. 29.—A contribution from the Reichsanstalt. This standard cell consists of cadmium, cadmium sulphate, mercury sulphate and mercury, and was brought out by Weston; cells of this kind were constructed by Czapski in 1884, and he called attention to their small temperature coefficient; for most cases, even for accurate measurements, no notice need be taken of the temperature, the correction being only about 0.004 per cent. per degree C. at 20°. In 1894 the Reichsanstalt began experiments with this cell and the results have shown that in constancy and capability of being reproduced this cell is not inferior to the Clark cell. He then describes in detail how cells of this kind may be constructed; two forms are described, the first being of the H type and the second being a portable form. The E. M. F. for a cadmium amalgam containing 7 to 14 per cent. of cadmium is 1.019 international volt at 20° if the value for the Clark cell at 15° is 1.433 international volt; a formula for the temperature coefficient is also given; according to their experience at that institution, this cell, like the Clark, may be reproduced and is constant to about one ten-thousandth.

Measuring Self-Induction Coefficients. Teichmueller. See abstract under Phase Meter.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Submarine Telegraphy. Rossel. *L'Eclairage Elec.*, Oct. 16.—The continuation of his serial. He describes a graphical method due to Ader for studying the transmission of electric waves in submarine cables and which enables one to study the signals produced in such a way as to determine the best conditions of transmission; he gives sufficiently accurate results to be applied to the study of transmitters; the results of such a study are important, as in a recent trial on the Marseilles-Algiers cable an improvement of 30 to 40 per cent. was obtained; with the improved receiver of Ader the gain in speed was 220 to 230 per cent.

Wireless Telegraphy. J. N. C. Kennedy. Lond. *Elec.* and *Elec. Rev.*, Oct. 29.—A brief communication defending Marconi's claim of originality. He states that there is no doubt that the vertical wire is the essential feature, and that the wire must be vertical he shows by quoting some notes from actual experiments; with vertical wires 100 feet in height, earthed at transmitter and receiver, the distance signalled was four miles, but when the wire was horizontal, the distance was only 150 yards; similar differences were obtained in other tests. It has been verified by actual experiment, beyond a doubt, that the distance signalled varies with the square of the height of the vertical wires; the cross-section of this wire is unimportant. At an early date Marconi will show that it is possible to impart impulses to the receiver in a sealed iron case.

Vocabulary for Code Telegrams.—Lond. *Elec.*, Oct 29.—A reprint of an appendix to the report of the British Postmaster-General, giving the conclusions of the conference at Budapest.

Water-tight Bell.—Lond. *Elec.*, Oct. 29.—A brief, illustrated description of a bell which will run under water; it is enclosed in a cast-iron case, the aperture for the moving to spindle being sealed by a flexible rubber cap or tube, protected from mechanical injury by a metal cap; one of these ran over 18 months under water.

British Telegraph and Telephone Department. Lond. *Elec. Rev.*, Oct. 29.—Abstracts of the Post Office report for 1896, giving some of the statistics of that department.

Construction and Working of a Typical Telephone Exchange. Wright. Lond. *Elec. Eng.*, Oct. 8.—The conclusion of his series of articles, the beginning of which was noticed in the *Digest*, Oct. 16.

Electric Signaling Clock. Elsaesser. *Elek. Zeit.*, Oct. 21.—A brief, illustrated article showing a cheap and simple apparatus which may be attached to a pendulum clock without material alterations, and will give an alarm at any predetermined time.

MISCELLANEOUS.

Sterilization of Water by Ozone. Engledue. Lond. *Elec. Rev.*, Oct. 29.—A brief communication suggesting that Andreoli (see *Digest*, Oct 30) should describe his methods and give data in terms of commercial units. He states that an apparatus (name not given) has been worked successfully and continuously for many months, supplying air highly charged with ozone, at an expenditure of two amperes (voltage not given) at the rate of 2000 cb. ft. per hour at a cost of two cents for the current (presumably per hour); this generator is now coming into commercial use; a system recently investigated by the Belgium Government uses ozonized air at a cost of 0.5 centime (0.1 cent) per cb. m. or 35 cb. ft.

Range Finders. Richards. *L'Eclairage Elec.*, Oct. 16.—In this installment of his long serial on mechanical applications of electricity he gives illustrated descriptions of the Greenough and the Obry systems; the latter is intended to enable one to aim cannon independently of the rolling of the ship by using an electrically operated gyroscope.

Effect of Alternating Currents on the Human Body.—Lond. *Elec. Rev.*, Oct. 22.—An abstract of the article which was noticed in the *Digest*, Oct. 23. This translation is reprinted in *Elec'ty* (N. Y.), Nov. 3.

Removing Microbes in the Body.—Elec'ty, Nov. 3.—A short editorial on Tesla's recent invention, pointing out the exaggerated accounts concerning it which were published in some of the daily papers. Tesla's true theory is that as two bodies charged with the same kind of electricity repel one another the charging of the surface of the human body with static electricity will similarly charge the invisible microbes, which will consequently be thrown off; the treatment is supplemented by bathing in some disinfectant and by a mild form of massage.

Motors for the Central London Underground Railway.

The equipment of motors for the Central London Underground Railroad will be of the gearless type designed by Prof. Sidney H. Short. They will be mounted on spring-supported sleeves, with flexible couplings similar to those successfully used for the past two years on the tunnel locomotives of the Baltimore & Ohio Railroad. Electric power will be supplied to these from a third rail, fed by rotary-transformer sub-stations from a high-pressure alternating-distribution system. Patents on these gearless motors for Great Britain have been assigned by Professor Short to the British Thomson-Houston Company, Limited. There is but little doubt that the gearless motor will come into general use for high-speed electric traction. With the increase of speeds already attained, the gear ratios have been proportionally cut down, and the further increase to high-speed express service will allow their ready reduction to a one to one ratio. As between the motor so geared and a direct-coupled motor, the latter has the enormous advantage of greater simplicity and fewer wearing parts. The use of the latter, however, involves the difficulty of greatly restricted space, as the wheel axle is necessarily at a certain fixed distance from the rail top. This difficulty, however, as well as that of the flexible support and coupling, seems to have been overcome in the designs of Professor Short.

A New Electric Smelting and Metal-Working Process.

In the past the mention of the smelting of ore and reduction of metals has been associated with the notion of enormous furnaces. We are familiar with these cumbrous and bulky appliances, and it is somewhat difficult at first to grasp the almost revolutionary electrical methods of reducing metals from their combinations, intensity depending on the amount of current, the resistance introduced and the nature, shape and mass of the material. It is by a utilization of the principle of developing heat by the introduction of an abnormal resistance in an electric circuit that Mr. George D. Burton's devices for smelting ores and heating metals for forging, etc., have been evolved, though on somewhat different lines and requiring different mechanical application.

The electric forge (Figs. 1 and 2) consists essentially of a tank containing an aqueous solution of some salt, preferably sodium carbonate and borax, as one electrode, and an insulated metallic bar or rest for the other. The work to be heated being placed upon the rest and the other end brought into contact with the surface of the liquid, an arc is produced at the point of

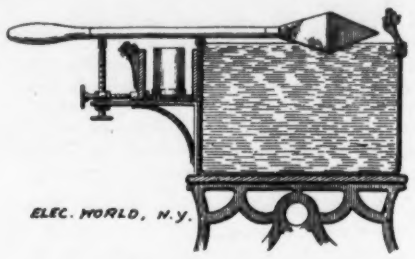


FIG. 1 —SOLDERING-IRON HEATER.

contact with the solution accompanied by great heat, the piece to be worked coming to a white heat in a very few seconds.

The heating effect can be confined to the end of the rod or piece to be worked or extended over a length of several inches. The piece being heated is continuously in sight, and with reasonable care melting of the piece is impossible. There is practically no oxidation, and the work is kept clean. The apparatus is always ready for use, and involves no waste when not actually in operation, beside which it reduces the danger from fire and is very convenient in operation.

The electric furnace or ore-reducer manufactured by the Burton Electric Smelting Company, of Boston, is constructed in different forms, one of these employing a liquid process similar in principle to that of the forge. Within a tank containing a suitable solution are suspended receptacles or crucibles with perforated bottoms, containing ore to be treated (Fig. 3), the solution below the crucibles is connected to one side of the electric circuit, while movable metal electrodes connected to the other side can be placed in contact with the ore within the crucibles. When the level of the solution is raised (by means of a plunger or otherwise) to such a height as to bring it in contact with the crucibles, the circuit is completed and the resistance encountered by the current in passing through the mass of ore develops heat. As the mass of ore diminishes in volume and the metallic products escape through the bottom changes in its resistance ensue, and the quantity of current passing can be regulated in various ways. For assay work, and where only comparatively small quantities of material have to be dealt with, the direct current can be used with success, but where operations on a large commercial scale are to be

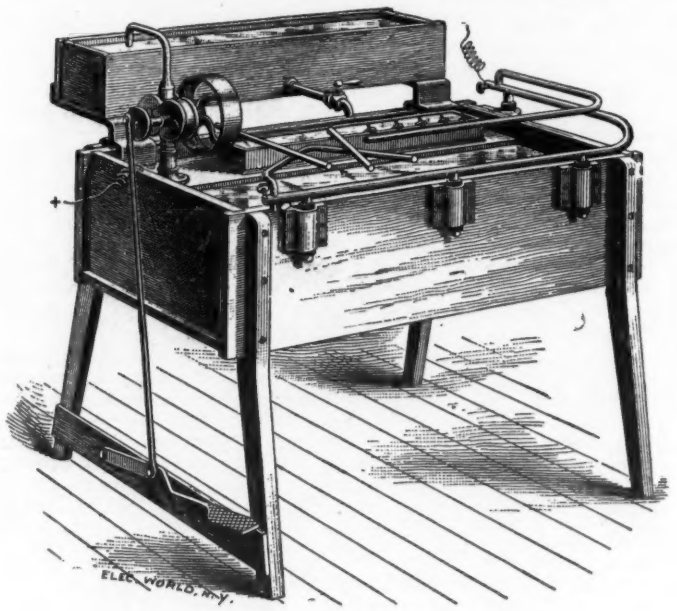


FIG. 2.—STANDARD ELECTRIC FORGE.

carried out the inventors prefer to use the alternating current, generating it at a convenient pressure and then transforming it down to a pressure of only a few volts.

Several other forms of electric furnaces or ore reducers are also manufactured. One consists of a non-conducting receptacle for the mineral to be refined (Fig. 4) into which conducting electrodes enter, their distance apart being adjustable. Means are also provided for leading off the gases and fumes generated to a receptacle where any ingredients may be recovered.

Considerable importance is attached to the method of regulation of the current by means preferably of a rheostat with numerous contacts placed in the field circuit of the shunt wound exciter of the alternator.

The special construction of the transformer with two massive rings as secondary windings gives excellent results. The quantity of ore which can be treated conveniently at one time in such a furnace varies according to the nature and quality of the ore, but it can be taken roughly at from 300 to 500 pounds, the ore being crushed into pieces of about the size of chestnuts, and if desired a number of furnaces can be operated by the same electrical apparatus, separately, consecutively or together.

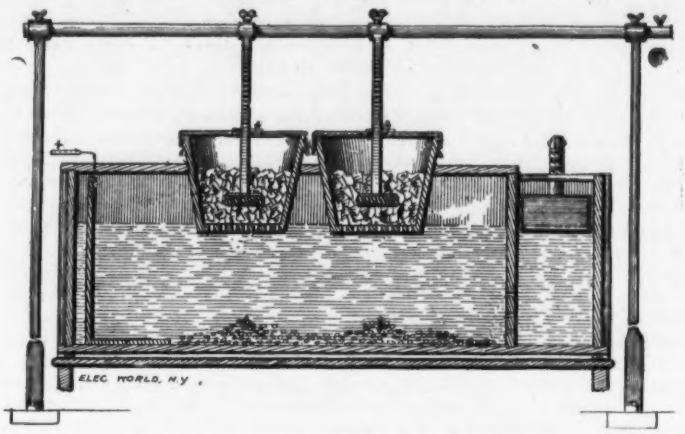


FIG. 3.—APPARATUS FOR ORE SMELTING.

The latest, and for some ores the preferred, form is that with the electrodes on the outside, and at the bottom, the essential principle, of course, being the the same in all the modifications. In the illustration a suction pump is indicated, to facilitate the removal of sulphurous and other vapors, as is also an air-pressure pump for forcing in air or gas from the top, if required.

One of the advantages claimed for this furnace is that in the case of several metals combined in the same ore those having lower fusing points than others can, by means of the facility of current and heat manipulation, be successively eliminated at the suitable heats respectively needed, whereas in the ordinary process of reduction of ores with combustion the heat cannot be regulated so as to accomplish this result. By the employment of the Burton method of heating a body of ore by electricity in such a furnace as described a governable heat can be produced throughout the entire mass without the use of a fan or blower, and without imparting to the ore under treatment any foreign gases

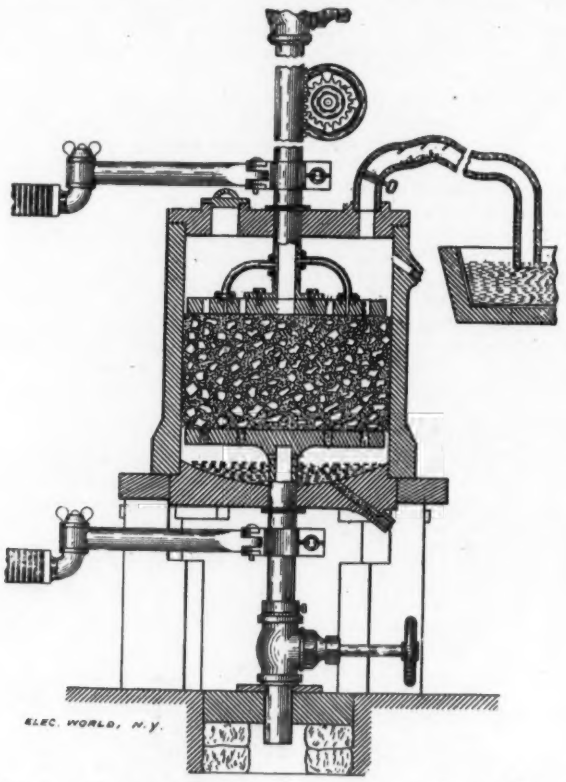


FIG. 4.—FURNACE FOR SMELTING LEAD OR SILVER ORE.

or detrimental impurities. The apparatus forms a clean, complete and economical device, rapid in its operation and easily cared for.

The office and factory of the Burton Electric Smelting Company are at 144 Lincoln Street, Boston. The officers of the company are Mr. George D. Burton, president and general manager; H. D. Tudor, treasurer, and Clarence Hale, secretary. Its board of directors are H. D. Tudor, Boston; Charles Williams, Somerville; Lester H. Williams, Brookline; Charles W. Parker, Boston, and George D. Burton, Boston.

NEWS OF THE WEEK

Financial Intelligence.

THE AMERICAN DISTRICT TELEGRAPH COMPANY has declared a dividend of 1 per cent., payable November 16.

DIVIDENDS.—The directors of the Erie Telegraph & Telephone Company have declared a regular quarterly dividend of 1 per cent., payable November 15.

BROOKLYN RAPID TRANSIT.—The gross earnings of the Brooklyn Rapid Transit Company for October last were $459,521, an increase of $20,825 as compared with the corresponding month of last year. For the four months ending October 31 the gross earnings were $1,920,986, an increase of $38,043.

THE ELECTRIC VEHICLE COMPANY, of Philadelphia, will, it is reported, offer its stock for subscription about November 15. The company's capital stock is $5,000,000, the par value per share being $100. Two hundred and fifty thousand dollars of the stock will be offered, all of which, it is stated, has been underwritten by a syndicate.

BREAK IN STOCKS.—On Friday last the stock market suffered sharp declines as the result of the circulation of various unfounded and absurd rumors. The general list of active stocks suffered as a result, and General Electric dropped 1¼ points. Western Union also declined 1⅝ points. Throughout the day the market was feverish, and at times demoralized. The denial of several of the rumors restored a better feeling to the market, and a partial recovery of the losses was shown at the close.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Nov. 10, 1897.

MR. H. C. PATTERSON, superintendent of the Municipal Electric Light & Water plant in Austin, Texas, was in New York last week making purchases for the enlargement of his station. Mr. Patterson, who as an electrical engineer is well known in the East, says Austin has a model municipal lighting plant.

THE NEW SOCIETY HOUSE of the American Society of Civil Engineers at 220 West Fifty-seventh Street, this city, will be formally opened on Wednesday, November 24. A programme, appropriate for the occasion, has been arranged. In the evening at 9 o'clock there will be a housewarming, to be followed by dancing and a supper.

THE VESTIBULE-CAR LAW will be resisted by the Consolidated Traction Company in Jersey City. The company has decided to ignore the act of the last Legislature, requiring the company to provide vestibules on all its cars. The law went into effect on November 1. The penalty prescribed is $50 for each car operated without a vestibule.

ANOTHER ELECTRIC ROAD TO THE SEA.—It is reported that the Brooklyn Heights Railroad Company is negotiating for the purchase of the Sea Beach road for the purpose of thereby securing a straight route to Coney Island. Should the negotiations be successful, electric power will probably be substituted for steam now used on the road.

FORECLOSURE SALE.—All of the real estate, chattels, franchises and plants of the State Electric Light & Power Company and the Amsterdam Electric Light, Heat & Power Company were sold on November 8, under foreclosure proceedings, at the Real Estate Exchange in Brooklyn. The property was bought in by Mr. P. C. Anderson, who represented the Amsterdam Company. The suit was instituted by the State Trust Company, of New York, which held a mortgage on the various companies.

TO COMPETE WITH GAS.—The Edison Electric Illuminating Company of this city, announces that in addition to its new wholesale schedule it will extend its discounts for long-hour use to customers having gross bills of $50 a month. This privilege, it is stated, will be extended for prompt payment only. The discounts will be as follows: Five per cent. for two hours', 10 per cent. for three hours', 15 per cent. for four hours', and 20 per cent. for five hours' consumption of current per day. It is thought that this reduction will greatly increase the demand for electric current, and it is stated that the gas companies intend to take some steps to protect their business, and prevent it from going over to their electrical rivals. The Edison Company is also prepared to supply to its patrons electric power motors with recording meters. It is stated that the Westinghouse Company will also take similar action.

STREET RAILWAY COMPANIES BURYING THE HATCHET.—It is reported that conferences have been held between the officers of the Metropolitan Street Railway Company and the Third Avenue Railroad Company, with a view to arriving at a harmonious understanding regarding joint crossings and other matters at issue between the two companies. It is also reported that the Metropolitan Company, by reason of this arrangement, will not oppose its rival in its endeavor to secure signatures to a new petition from property-owners on the Kingsbridge Road for the extension of the company's Amsterdam Avenue line, and that the Third Avenue Company will allow the Metropolitan Company to construct a cross-over at 116th Street, and also permit the laying by the Metropolitan Company of an electric subway on Park Row, from the Bridge to the Post Office, for the use of the Fourth and Madison Avenue lines of cars.

A PECULIAR ACCIDENT occurred on Saturday night last on the Ninth Avenue division of the Prospect Park & Coney Island Railway Company in Brooklyn. About 7:30 o'clock a car was being switched at the Park Circle from the east-bound to the west-bound track, and in jolting over the switches the trolley pole slipped from the wire. It flew up in the air, and in trying to replace it on the wire, the conductor gave it an extra hard pull, with the result that several of the span wires were pulled from their fastenings. The trolley wire, thus left without support, sagged, and the strain of the drooping wire caused other span wires to give way for a distance of 2½ miles. The trolley wire lay on the ground and emitted a shower of sparks at different points, but further than this no injury resulted. The condition of things on the car which caused all the trouble was rather exciting for a few moments. It is stated that several persons received slight shocks of electricity and left the car in great haste and alarm. It took three hours to replace the trolley wire and restore order out of the entanglement.

NEW ENGLAND NOTES.

BOSTON, Mass., Nov. 8, 1897.

MR. HERBERT W. SMITH has accepted a position with the Bibber White Company, Boston, as manager of the railway department.

THE OLD BOSTON CLUB, now known as the Electric Potential Club, will give a dinner at the Hotel Thorndyke, Boston, on Friday evening of this week. A number of prominent electrical gentlemen have been invited. The table will be set for ninety covers. Mr. H. Barringer Cox, of New York, will give a little talk on the subject of "Direct Conversion of Heat."

THE WHEELER REFLECTOR COMPANY, Boston, is one of the few companies that always gets its share of business. It has been so long in business, and its products are so well and favorably known, that the trade appears to naturally have it in mind when ordering reflectors or shades. This is certainly a happy condition, but not at all surprising, with Gen. Elbert Wheeler at the front, and constantly pushing forward the excellent specialties of this company. The company is known in foreign countries as well as at home. Only a few days ago an order was received from South America for about 4000 Wheeler reflectors and shades.

BUFFALO AND NIAGARA FALLS NOTES.

BUFFALO, N. Y., Nov. 8, 1897.

THE NIAGARA FALLS POWER COMPANY has mortgaged all the tunnel property to the Central Trust Company, of New York, for $10,000,000, to secure the payment of its bonds.

THE BUFFALO TRACTION COMPANY has applied for a lease of a part of the conduit line now being laid by the transmission company, and will probably erect a transformer house of its own in time to receive the additional current from Niagara Falls.

ELECTRIC-LIGHTING CONTRACT.—Niagara Falls is about to contract for electric lights at $84 per light, which is $6 less than is now paid. The only bidder is the Buffalo & Niagara Falls Electric Light & Power Company, of which George Urban, of Buffalo, is president. The contract will be for five years. Since the light-station was placed in charge of Frank G. Lott it has been greatly improved.

MORE NIAGARA POWER FOR BUFFALO.—It is arranged that the Buffalo street railway line shall receive the first additional power from the Niagara Power Company. It is a problem as to the time when that will be, as everyone connected with the work appears to have a different opinion in regard to it. After that company is given 1000 horse-power (it has that amount already), other contracts will be filled as rapidly as possible. There is much impatience over the coming of the power, but the power people have a way of referring, whenever complaints are heard, to the fact that they waited a year for Buffalo to admit them.

TO CHANGE FROM HORSES TO ELECTRIC POWER.—The street-car line from Niagara Falls, Ont., to Drummondsville, is to be changed from horse power to electricity. The reason for the retention of the old-fashioned motive power so long is that the officials of the road failed to come to an understanding with the town. The difficulty has now been adjusted, and application has been made to the Niagara Falls Park & River Railway Company for power. This latter company has long been anxious to dispose of its surplus power, and having now obtained government permission and a customer in the Drummondsville road, it has taken steps for the purchase of a new generator.

PITTSBURG NOTES.

PITTSBURG, Pa., Nov. 8, 1897.

INCREASED EARNINGS OF THE CONSOLIDATED TRACTION COMPANY.—At a meeting of the directors of the Consolidated Traction Company, held on November 3, a report was submitted, showing that the total receipts of the company for the month of October amounted to $178,905.80. The increase over the corresponding month last year is $22,941.34.

OHIO TROLLEY ROAD REACHING TOWARD PITTSBURG.—The application of the Mahoning Valley & Southeastern Electric Railway Company to the County Commissioners for a franchise to build a trolley road, 6 miles

long, east of Struthers, Ohio, has been granted. It is expected that the road will be completed next spring, and eventually be extended to Mahoningtown. There are projects on foot for closing up the gaps in the Beaver and Ohio Valleys between Mahoningtown and Pittsburg, so that the new road may soon have connections with this city.

ISOLATED PLANTS THREATENED BY THE ALLEGHENY COUNTY LIGHT COMPANY.—An interesting action was begun last week by the Allegheny County Light Company against I. Jackson & Bro. The case is regarded as a test one, and is designed to determine whether private individuals have the right to sell electric light and power without taking out a State charter. The proceeding is a petition to the Attorney-General asking for a writ of quo warranto. The Attorney-General has fixed November 16 as the date for a hearing in the case. It is thought that the owners of several of the large isolated plants, who are selling surplus light and power to their neighbors, will join in fighting the case, which is regarded as one of great importance. An official of the Light Company states that they have no complaint to make of competition from chartered corporations which are subject to the same restrictions and pay the same taxes as the Light Company; their protest is against competition from individual manufacturers, who are free from these items of expense, and who in consequence have an unfair advantage. The result of the action will be looked for with great interest.

CHICAGO NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., Nov. 8, 1897.

THE GENERAL ELECTRIC ORDINANCE.—The Illinois Supreme Court has handed down a decision granting a rehearing to the Attorney-General in the case against the General Electric ordinance. The whole case will therefore be reargued.

CONSOLIDATION of all the elevated railroad companies in this city into one concern is again the subject of rumor, and it is likely that this result will finally be accomplished. The plan having this object in view is beginning to assume tangible shape. Mr. Charles T. Yerkes is said to be at the head of the enterprise, which, if carried out, will place him in control of every elevated line in the city of Chicago. The plan is to form a new corporation, with a capital stock of $50,000,000.

THE WESTERN ELECTRIC COMPANY has furnished a room at the rear of its store as a show room for fixtures. Numerous chandeliers and brackets have been placed in this room, and these have been wired up with 2-point, 3-point, 4-point, and combination switches, in order to show the method by which lights in private houses may be controlled. A large variety of beautiful shades is shown on the fixtures. Five of the Western Electric Company's enclosed electric-arc lamps are also exhibited.

EXTENSIONS OF THE ELECTRIC-LIGHT SYSTEM.—As was noted in a recent issue of THE ELECTRICAL WORLD, $150,000 was appropriated by the City Council for the extension of the electric-light system in this city. The manner of expending this sum was the subject of a recent conference between Comptroller Waller and City Electrician Ellicott, and it was determined to divide the new territory to be lighted into districts and install a plant in each. Each plant will have a capacity of about 600 lights. One will be located on the South Side, one on the West Side, and one on the North Side. The South Side plant will obtain its power from the Sixty-eighth-Street pumping station; the West-Side plant will get its power from the new Central Park Avenue station, and that on the North Side from the Lake View station. Another district may be established later. City Electrician Ellicott estimates that he can install somewhere about 2400 new lights with the money at his disposal.

ST. LOUIS NOTES.

ST. LOUIS, Mo., Nov. 8, 1897.

ARC LIGHTS are to be placed on the tower of the City Hall to light the building and neighborhood at night. This will make the tower a prominent feature of the city after nightfall.

THE FOREST PARK SCENIC RAILROAD COMPANY is the title of a concern which applied to the City Council last week for a franchise to build an electric railway in Forest Park.

THE ST. LOUIS & SUBURBAN RAILROAD COMPANY has asked the City Council for two franchises. The first gives the St. Louis & Kirkwood road the right to run out Clayton to Rosedale. The second gives the St. Louis & Meramec Railroad the right to run a track northward along Sarah Street.

THE FARMINGTON RAILWAY & POWER COMPANY has been formed to construct an electric railway from Delassus to Farmington, in St. Francois County. The line will be 2¾ miles long. The capital of the company is $40,000. The officers are George C. Martin, president; W. E. Bailey, vice-president and manager; John H. Martin, secretary and treasurer.

PROBABLE CONSOLIDATION OF ELECTRIC ROADS.—It is probable that the St. Clair County Turnpike Association and the Belleville-St. Louis Electric Railway Company will effect a consolidation. Some time ago the electric road received a franchise to build a line from the public square in Belleville to the Eads Bridge in East St. Louis. Trouble was experienced in regard to compensation for the right to build on the turnpike. It is now proposed to consolidate the two interests, and the turnpike company has deposited $10,000 to bind the contract.

TELEGRAPHERS' CLUB.—Two hundred St. Louis telegraphers at a recent meeting organized a club. They will secure quarters downtown, and they propose to have a reception room, reading room, game room, gymnasium, bathroom and café. The following-named gentlemen were elected officers for the first year: President, A. B. Ellison; vice-president, T. E. Bastable; secretary, C. W. Frey; treasurer, M. M. O'Neil. The Board of Directors is composed of seventeen prominent telegraphers. At the first meeting several honorary members were elected.

MEXICAN NOTES.

MONTEREY, MEXICO, Nov. 1, 1897.

A NUMBER of the principal silver mines around Monterey have their own electric-light plants, and some of the new mines are contemplating putting in similar improvements.

THE FIRST ELECTRIC RAILWAY IN MEXICO is now in process of construction. It will connect the pretty little mountain city of Jalapa, in the State of Vera Cruz, with the city of Cordoba, in the same State. A considerable part of the road is already completed. It will be a freight as well as a passenger line. Cordoba is the centre of a rich coffee-raising district.

A STRONG FIGHT was made on the Monterey Electric Company recently because the latter charged customers for the incandescent lamps which they used. An effort was made to organize a company to establish a competitive plant, and considerable success was had, but it is believed that the matter has been dropped, for nothing has recently been heard of it. The local plant is giving very general satisfaction, its service being cheap and good.

THE PROJECT to consolidate the two street-railway systems of this city into one corporation and convert all of the lines from narrow to broad gauge and apply electrical power to them, has again been revived. About a year ago it was thought that such a deal was virtually consummated, but before the papers were signed some hitch occurred and negotiations were suspended. It is reported that the new corporation will be composed of Eastern capitalists, Pittsburg and New York parties being largely interested.

THE ELECTRIC-LIGHT PLANT in the city of San Luis Potosi passed into the hands of New York and other Eastern capitalists a few months ago, and since then extensive improvements have been made in the system, and the service greatly improved. It is reported that the new company proposes to expend $200,000, gold, in new machinery. The plant is now in charge of a capable American manager, chief electrician and superintendent. San Luis Potosi has a population of about 80,000 people, and is the capital of the State of the same name.

IN THE EARLY part of the summer just passed, General Bernardo Reyes, Governor of the State of Nueva Leon, of which this city is the capital, built himself a magnificent summer residence near the summit of Mitre Mountain, overlooking the city of Monterey. The beautiful residence and grounds are supplied with all modern conveniences and appliances, among them being a complete electric-light plant. In the darkness of the night these many bright lights afforded a beautiful display far up the mountain side, and can be plainly seen from this city.

CANADIAN NOTES.

OTTAWA, Ont., Nov. 8, 1897.

THE DIRECTOR of the Meteorological Observatory at Toronto has interviewed the Government in respect to the proposed removal of the magnetic instruments in the observatory to another location. A spot about 9 miles from Toronto has been selected, which will be free from the influence of the electric railway system which has destroyed the usefulness of the observatory in Toronto.

CHEAP POWER.—Alderman Hallam, of Toronto, intimates, in a letter to the mayor of that city that he is one of a company which is prepared to supply the corporation with electrical energy at one-quarter of a cent per horse-power per hour, direct from Niagara Falls. The Toronto City Council now has before it a proposal to purchase electric energy from the Aqueduct Company at one-half a cent per horse-power per hour.

IT IS REPORTED that the Niagara Falls Park & River Railway Company, on the Canadian side of the river at Niagara Falls, has at length secured the right to deliver surplus power to all applicants. It is also stated that the privilege of using power has been granted to a party of capitalists on the New York side of the river, for the purpose of promoting industrial schemes which will have an important bearing to both sides of the river.

THE HULL (QUE.) ELECTRIC COMPANY has purchased the Aylmer branch of the Canadian Pacific Railway, which is at present under lease, the price being in the neighborhood of $100,000. The purchase only requires ratification by the Dominion Parliament. Since leasing this piece of road the Hull company has double-tracked it from Hull to Aylmer, improved the road-bed and in other ways greatly enhanced the value of the line.

THE NET PROFITS of the Montreal Street Railway for the year ending October 1 were $507,885.60, on a capital of $4,000,000. The company has increased its rolling stock during the year by the addition of fifty-five closed motor cars and twenty-five open motor cars, constructed at the company's own workshops; twenty-two more motor cars are under construction for the winter's service, and also sixty more open motor cars for anticipated increased traffic next summer. The capital stock of the company is now $5,000,000. The surplus over liabilities is $334,247.26.

THE ROSS-MACKENZIE STREET RAILWAY SYNDICATE, the chief members of which are James Ross, of Montreal, and William MacKenzie, of Toronto, will soon be the largest owners of electric car systems in the world. The syndicate will at once begin the construction of a trolley system, 23 miles long, in the city of Kingston, Jamaica. The syndicate is keeping an eye on the transportaion problem in London, England, and Mr. MacKenzie hopes soon to obtain an opening there. Among the roads at present controlled and largely owned by the syndicate and its friends, are the electric street railways of Montreal, Toronto and Winnipeg, in Canada, and of Birmingham, England.

THE DESCHENES ELECTRIC COMPANY has recently taken out a license to supply electric light and power in the city of Ottawa and County of Carleton. This company was organized in July last. The company obtained a lease from the Dominion Government to lay cables from the Ottawa River at the foot of the locks of the Rideau Canal, and along the canal for a distance sufficient for its purpose. In return for this privilege the company is to supply electric current free to light the canal locks, basin, etc. It is understood

that the company has arranged to deliver the current to the cables of the Hull Electric Company at the water's edge in Hull. The work of laying the cables across the Ottawa River was skillfully carried out under the direction of Mr. Stevenson, the expert sent by the National Conduit & Cable Company, of New York City.

English Notes.

(From Our Own Correspondent.)

LONDON, October 19, 1897.

CENTRAL LONDON RAILWAY.—It is stated that there are thirty shields at work upon the construction of the Central London Railway, over 3000 men being employed. The tunneling process is about half completed. Considerable difficulty has been encountered at the Bank station—which is to be the city terminus, and not Liverpool Street, as at first intended—owing to the city sewage pipes being in such close proximity. According to the *Railway News* Christmas of next year is the earliest date of opening.

THE "ANDREW" SYSTEM OF FEEDER CUT-OUTS.—Mr. L. Andrews, the engineer and manager of the electric-supply system at Hastings and St. Leonards-on-Sea, has devised an ingenious system of cut-outs for isolating faulty feeders from a network of primary mains, without interrupting the supply to any of the sub-stations. The arrangement of feeders is substantially such as to form a triangulated system between all the sub-stations and the central station, thus affording an alternative path for the current from the central station to any sub-station. In each feeder are placed, at opposite ends, two cut-outs. One of these cut-outs is operated when the current exceeds a certain safe value, and the other cut-out acts whenever the current reverses. The effect of these two kinds of cut-outs is as follows: Should a feeder become short-circuited, the heavy current produced will cause the first-named cut-out to act and isolate the feeder at that end. Then the current flowing back through the other end of the feeder will operate the reversed current cut-out, which will disconnect the feeder at that end. Thus, in quick succession, both ends of the faulty feeder will be disconnected, and the effect of the short circuit will be removed from the system. There being an alternative path, the removal of the feeder does not interfere with the supply to the sub-station to which the feeder is connected.

ELECTRICAL COMMUNICATION WITH LIGHTHOUSES AND LIGHT-VESSELS.—The fifth and final report of the Royal Commission appointed to inquire into what lighthouse and light-vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication has just been issued. The four previous reports were issued respectively in February, 1893, April, 1894, May, 1895, and June, 1896. The report is of a lengthy and exceedingly interesting character, a large amount of space being devoted to the minutiæ of what is known as the "sunk" system of electrical connection with lightships, and a discussion of the breakdowns which have occurred with this device and of the remedies which have been tried and adopted. The "discontinuous" system of connection, as it is called, which has been established between the mainland and the Fastnet, would appear at last to have got into working order. This system, as your readers may perhaps recollect, consists merely in running a cable from the mainland into the close vicinity of the rock upon which the outlying lighthouse is situated, and there terminating in a copper conductor in a heavy copper "mushroom," while on the lighthouse, in connection with the instruments, heavy copper cables are run into the sea on the side nearest to the copper "mushroom" and on the far side, communication, if sufficiently strong currents are employed, being possible through the short break of sea water. The commissioners state that, of course, there has been no difficulty in connecting the headland and pile lighthouses with the shore, and that the difficulties in connection with exposed lightships are entirely of a mechanical order, which, although possible to overcome with the less exposed ships, are, in the opinion of the commissioners, such as to render the system impracticable in the case of vessels exposed to heavy seas, strong currents and moored in deep water. It was with a view of evolving a system useful for ships in exposed positions that the commissioners experimented with the device suggested by Mr. Sydney Evershed, which consisted in coiling a cable at the bottom of the sea in a circle round the ship and encircling the lightship itself with another coil, and sending Morse signals by means of intermittent currents inductively to a telephonic receiver on board the ship, and vice versa. Owing, however, to the intervening space of conducting sea water, amounting in some cases to 10 fathoms, it was found impossible to effect communication by means of induction. Failing all these experiments, the Royal Commission at last turned its attention "to a system of signaling through the ether without wires, which had been brought to the notice of the Post Office authorities by Signor Marconi," and in the event of a system of "ethereal communication being perfected they recommend the connection at a future date of a large additional number of lighthouses and light-vessels." The commissioners are of opinion that if their recommendations are adopted all the most urgent cases will have been dealt with, and that a very fairly complete system of electrical communication with lighthouses and light-vessels will have been established around the coasts of the United Kingdom. In conclusion, the commissioners desire to express the hope that the practical establishment of electrical communication will not be allowed to drop now that their existence as a commission comes to an end. They point out that the working of the system in this country depends to a very large extent upon the co-operation of a number of departments, including the Board of Trade, the Post Office, Trinity House, and other lighthouse authorities, the Royal National Lifeboat Institution and the Admiralty. The commissioners state that from each of these departments they have received most valuable assistance in the course of their inquiry, and they trust that in the future some arrangement may be adopted by which the co-operation of these numerous departments may be effected, a hope which all interested in this interesting subject of electrical communication with lighthouses and light-vessels will echo.

General News.

New Incorporations.

THE CONFLUENCE, URSINUS & ADDISON TELEPHONE COMPANY, Confluence, Pa., has been chartered.

THE STANBERRY TELEPHONE COMPANY, Stanberry, Mo., has been formed, with a capital stock of $10,000, by L. M. Hall and A. C. Frisbie.

THE NATIONAL ELECTRIC COMPANY has been incorporated at Stamford, Conn., by Walton Ferguson, Anthony N. Brady and others.

THE KALAMAZOO TELEPHONE COMPANY, Kalamazoo, Mich., has been organized, with a capital stock of $25,000. W. C. Asbun is manager.

THE INTERSTATE TELEGRAPH COMPANY, St. Louis, Mo., has been organized, with a capital stock of $20,000. The incorporators are H. L. English and D. J. Sullivan.

THE PRESTON LIGHT & WATER COMPANY, Preston, Iowa, has been incorporated, with a capital stock of $10,000. Those interested are A. L. Bartholomew and I. M. Gillett.

THE H. P. HILL LIGHTING COMPANY has been incorporated at Washington, D. C., with a capital of $10,000. The incorporators are H. P. Hill, F. J. Whitehead and A. L. Bogan.

THE PARKERSBURG & MARIETTA TRACTION COMPANY, Parkersburg, W. Va., has been incorporated. The company will construct an electric railway from Parkersburg to Marietta, Ohio.

THE EQUITABLE ELECTRIC LIGHT COMPANY, Lake Geneva, N. Y., has been organized, with a capital stock of $9000. The incorporators are Frank Rogers, H. B. Tyrrell and W. J. Cutteridge.

THE CITIZENS' TELEPHONE COMPANY, of Delaware, has been incorporated at Columbus, Ohio, by Lyman P. Lewis, Edward L. Barbe, James S. Bailey, Jr., Charles D. Juvinall and J. C. Wood.

THE WESTERN ELECTRICAL COMPANY, Omaha, Neb., has been organized, with a capital stock of $10,000. Among those interested are E. G. McGilton, G. W. Johnston and Lawrence Rath.

THE MONTOUR FALLS ELECTRIC LIGHT COMPANY, Montour Falls, N. Y., has been formed, with a capital stock of $10,000. The directors are Eli A. Dunham and Fred. J. Dunham, Montour Falls.

THE FARMERS & MERCHANTS' TELEPHONE COMPANY, Barry, Ill., has been organized, with a capital stock of $3500. The incorporators are F. A. Crandall, G. W. Chrysup and Henry L. Longerhaus.

THE PELHAM STREET & SURFACE RAILWAY COMPANY, Pelham, N. Y., has been formed by Jacob Heissler, as president; Frank M. Lyon, secretary, and John M. Young, treasurer. Capital stock, $30,000.

THE BLUE RIVER ELECTRIC POWER COMPANY has filed articles of incorporation at Denver, Col., with a capital stock of $50,000. The directors are Mason H. Kern, Newark L. Burton and William H. Kern.

THE KALAMAZOO GAS & ELECTRIC COMPANY, Kalamazoo, Mich., has been incorporated with a capital stock of $200,000. This new corporation has been formed to succeed the Kalamazoo Heat, Light & Power Company.

THE BLUE RIDGE ELECTRIC RAILWAY & POWER COMPANY, Waynesburg, Pa., has been formed, with a capital stock of $50,000. Those interested are Roger W. Barron, president, and Winfield S. Cahill, treasurer, both of Baltimore, Md.

A STOCK COMPANY is being organized in Granville, N. Y., for the purpose of building an electric road from Whitehall to Granville. Capital stock, $16,000. Those interested are R. M. Witherbee, John O'Neill, R. H. Cook, Frank Baker, I. L. Bush, and others.

THE MILFORD & WOONSOCKET STREET RAILROAD COMPANY, Milford, Mass., has been incorporated by W. S. Reed, of Leominster; W. H. Tylee, of Worcester, George E. Tylee, of Corning, N. Y.; Charles W. Shippee, Milford, and others. Capital stock, $100,000.

THE CRESTLINE TELEPHONE COMPANY has been incorporated at Columbus, Ohio, for the purpose of constructing and operating a telephone exchange in Crestline, with toll lines extending to Bucyrus. Among those interested are W. S. Johnson, Frank A. Huffman, Guy Huffman, Mary I. Johnson and Edward R. Tarr. Capital stock, $6000.

THE MIDDLEBURG TELEPHONE COMPANY, Middleburg, N. Y., has been incorporated, with a capital stock of $1,000. The directors are John H. Wickie, Christopher S. Best, Daniel Frisbie, Alonzo Almy, M. W. Becker, Jerome B. Badgby, Albert E. Reina, Charles W. Vrooman, George Danforth, Jacob Engle, John H. Cornell, Wellington Bassler and William H. Nevith.

THE WASHINGTON, WESTMINSTER & GETTYSBURG ELECTRIC RAILWAY COMPANY has been granted a charter by the State Department at Harrisburg, Pa. The purpose of the company is to build a line 14 miles long, from Gettysburg to the State line. The directors are James B. Colgrove, Samuel S. Bushman, Charles A. Trastel, Henry C. Little, Henry A. Cady, Charles H. Duttera and John A. Shore. The capital stock is $400,000.

THE DETROIT, ANN ARBOR & YPSILANTI ELECTRIC RAILWAY COMPANY, Ann Arbor, Mich., has been organized, with a capital stock of $400,000. The incorporators are James D. Hawks, S. F. Angus, John C. Liggett. It is the intention of the company to build from the present terminus of the Detroit Electric Railway in Springwells to the city line of Ypsilanti, there connecting with the Ypsilanti & Ann Arbor motor line, and probably eventually consolidating with it.

THE NEW AMSTERDAM GAS COMPANY, New York, N. Y., has been incorporated at Albany, with a capital stock of $23,000,000, $10,000,000 of which

is preferred. The company will carry on operations in New York City and County, and in addition to manufacturing and supplying gas for lighting purposes, it intends to manufacture and supply electricity for lighting, heating and power purposes. The directors of the company are Edward M. F. Miller, James Tolfree, F. L. Eldridge, William C. Cox, Charles M. Billings, William T. Eldridge, Sherman Flint, Frederick P. Voorhees and Matthew T. Johnson, of New York City; John B. Summerfield, of Brooklyn, and Noel Gale, of Clinton, Richmond County.

THE TELEGRAPH AND TELEPHONE.

PLYMOUTH, MO.—A telephone line is being built between Plymouth and Ludlow by Mr. N. H. Bair.

YAZOO CITY, MISS.—A telephone system is to be established here, giving connection with all parts of the county.

MAUSTON, WIS.—Mr. H. H. Heath, of this place, has secured a ten-year franchise for a telephone system in Neillsville.

ALAMOSA, COL.—A new telephone line between Manassa, Sanford, La Jara, Conejos and Antonito will be built before cold weather.

PLEASUREVILLE, KY.—The Ohio Valley Telephone Company has been granted permission to establish a telephone exchange in this place.

FLINT, MICH.—The City Council has granted a franchise to the State Telephone Company, which will establish an exchange in this place at once.

CLAY CENTRE, KAN.—Some capitalists of Hiawatha propose to establish a telephone system in this place. It will be constructed in a first-class manner.

SAGINAW, MICH.—The Valley Telephone Company has deposited two bonds of $10,000 with the city authorities, and has begun laying its underground conduits.

CAMDEN, N. J.—The Delaware & Atlantic Telegraph & Telephone Company has petitioned the Council of this place for permission to place its wires in that town underground.

ASTORIA, ILL.—The Fulton County Telephone Company has nearly completed its lines in Fulton County. This company is a home institution, all the stock being owned in the county.

GROVE CITY, OHIO.—The citizens of this town are agitating the question of establishing a telephone system here, and will endeavor to have the Central Union Telephone lines extended to this place.

ELIZABETHTOWN, KY.—The Ohio Valley Telephone Company will build a line from Elizabethtown to Leitchfield at once, taking in way points, and will extend the line to Bowling Green and Hodgeville.

FROSTBURG, MD.—The Maryland, Pennsylvania & West Virginia Telephone & Telegraph Company is securing right of way for metallic circuits to connect Frostburg, Somerset, Bedford, Fayette and Westmoreland, Md.

CHILLICOTHE, OHIO.—The Bell Company has purchased the telephone line connecting Omega, Waverly, Piketon and Jasper, and will soon extend the line to Richmond Dale, where it will be connected with the line to this city.

ONTONAGON, MICH.—Houghton County capitalists have organized a telephone company in this place. The company will run in opposition to the Bell Company, which has been operating here for many years, and will reduce rates.

FULTON, MO.—W. N. Birkhead & Co. are constructing a telephone line from Montgomery City to Fulton. They will extend the line to Jefferson City by way of Carrington, Guthrie and New Bloomfield, if they meet with sufficient encouragement.

ELECTRIC LIGHT AND POWER.

GALLATIN, MO.—A municipal electric-light plant is to be built at this place.

SALEM, N. Y.—At a special election held on November 1. the electric-light resolution was carried.

TROY, OHIO.—The City Clerk has been authorized to advertise for sale $18,000 electric-light bonds.

NORTH WILBRAHAM, MASS.—An electric-light plant for this place is one of the early possibilities.

SCOTTSVILLE, N. Y.—An electric-light plant for this place is projected. A company is now being organized.

SAVANNAH, GA.—The City Council has appointed a committee to receive estimates for building a municipal electric plant.

PROVIDENCE, KY.—The Providence Coal Company has purchased an electric light plant, and will put the same in operation at its mines.

ATLANTA, GA.—A committee has been appointed by the City Council to report on the question of municipal ownership of an electric light plant.

GREENWOOD, S. C.—At an election on October 19, it was voted to issue $40,000 in bonds for the building of an electric light plant and water works.

SHORT HILLS, N. J.—The Millburn Electric Light Company will double its capacity by adding a 200-hp boiler, an engine of 250 horse-power and a dynamo.

ROCHESTER, VT.—Mr. Charles G. Winslow is installing a 500-light plant for the Rochester Electric Light & Power Company. The current is generated at a water power 1½ miles from the village.

FALLSTON, PA.—The Beaver River Power Company has begun work on the construction of its plant. The company will furnish light, heat and power by means of dynamos operated by water power.

LANCASTER, KY.—Owing to the continuance of the drought the electric-light company here has been compelled to discontinue its lighting service. The drought has lasted for several months, and much suffering is being experienced.

EUREKA, ILL.—C. C. McDonald, of Fairbury, has purchased the electric-light plant in this city, and has taken possession of it. The plant is well equipped, and Mr. McDonald will put the plant and line in first class shape at once.

DUNKIRK, N. Y.—It has been decided that the city shall purchase a dynamo for the purpose of furnishing incandescent light for the public buildings. The plant will be owned and operated by the city in connection with the water works and municipal street arc lighting.

JERSEY CITY, N. J.—The Hudson County Board of Freeholders has decided to light the Hudson Boulevard by contract, instead of maintaining the electric-light plant now in operation. It is stated that numerous complaints regarding the inefficiency of the county employees in charge of the plant and of frequent breaking down of the machinery have been made.

BALTIMORE, MD.—The Northern Electric Company, of this city, is sending out notices to the effect that it has purchased the contracts, business, franchises and property of the United States Electric Power & Light Company, and is now filling its lighting contracts. The company is now putting in a new equipment in its central station. Mr. J. F. Morrison, who is one of the oldest electric-light men in the country, has accepted the position of general manager under the new organization, and will personally direct the practical operations of the company.

THE ELECTRIC RAILWAY.

MANCHESTER, VA.—An electric railroad will be built from Manchester to Petersburg. Mr. W. M. Habliston is interested.

KIRKLAND, N. Y.—The proposition to build an electric road from Whitestown to Kirkland and Clinton, meets with much approval.

DUDLEY, MASS.—The Webster & Dudley Street Railway Company has petitioned the Selectmen for a franchise to operate in this city.

PHILADELPHIA, PA.—The Northwestern Passenger Railway Company has petitioned the City Council for a franchise to operate its road in this city.

CHICAGO, ILL.—The Chicago Electric Transit Company has secured the necessary frontage for the construction of 4 miles of street railway, and will begin work immediately.

NORTHAMPTON, MASS.—A franchise for the construction of an electric railway between this place and Cummington has been granted to the Pittsfield Street Railway Company.

BOSTON, MASS.—The Boston, Milton & Brockton Street Railway Company is the name of a newly organized company. It proposes to construct a line from Boston to Brockton.

WORCESTER, MASS.—At a special meeting of the Selectmen October 28, a franchise was granted to the Worcester & Clinton Street Railway Company to lay tracks from Boylston to Clinton.

BALTIMORE, MD.—The Baltimore, Halethorpe & St. Denis Railroad Company has asked the Commissioners of Baltimore County for permission to extend the route of its proposed electric road.

MECHANICVILLE, N. Y.—It is expected that the proposed electric railway from Mechanicville to Waterford, N. Y., will be constructed in the spring. The road will be operated by the Stillwater & Mechanicville Company.

ELWOOD, IND.—The formation of a company of capitalists to build a railroad from Toledo, Ohio, to Brazil, Ind., via Elwood and Indianapolis, is being consummated. The company is headed by J. H. Taylor, of St. Louis.

NORTHBRIDGE, MASS.—The Board of Selectmen of this place voted to grant a franchise to the Worcester & Blackstone Valley Street Railroad Company to extend its tracks to the village of Rockdale, in the town of Northbridge.

LEWISBURY, PA.—Residents of this place are very anxious to secure an extension of the New Cumberland branch of the Harrisburg & Mechanicsburg Electric Railway to this place. The company will be asked to make the extension.

SANDUSKY, OHIO.—It is stated that an Eastern syndicate is endeavoring to secure control of all the electric street railway lines in this city, the object being to consolidate them into one line. It is also proposed to extend the consolidated line to various cities in this section of the State, including Cleveland.

NORRISVILLE, PA.—The Newtown & Delaware River Traction Company organized. President, Lewis A. Conwell, of Philadelphia. Directors: William F. Breitenbaugh, George Kessler, vice-president of the Integrity Title, Insurance, Trust & Safe Deposit Company, etc. The company promises to build a trolley line from Norrisville to Newtown.

ANN ARBOR, MICH.—Another movement is on foot for an electric railroad between Detroit and Ann Arbor. S. F. Angus, manager of the Home Life Insurance Comapny, in Detroit, represents capital that is prepared to go into the Detroit & Ann Arbor road, providing some difficulties that at present stand in the way are overcome. No franchises have yet been secured.

SOUTH BETHLEHEM, PA.—A project is on foot to extend to Quakertown the trolley system which has been built from South Bethlehem to Hellertown. The matter is being pushed by New York parties. It is also reported that a similar project is on foot to extend the electric road, which is being built from Willow Grove to Doylestown on through Bedminster, Blooming Glen, Sellersville, Perkasie to Quakertown, and connect with the system from Bethlehem.

ST. JOSEPH, MO.—The directors of the St. Joseph Railway, Light, Heat & Power Company have given to General Manager Van Brunt their permission for two important projects to the street-railway service of this city. They have decided that the line to the Stock Yards shall be built at once. The directors

also decided to ask of the Common Council a franchise that will enable them to lay their tracks in Sixth Street, from Patee to Messanie, and to ask that permission be embodied in that franchise to use the tracks now lying on certain other streets.

JERSEY CITY, N. J.—An order was signed in the Chancery Court in this city on Oct. 30, on behalf of the runswick Traction Company, which interferes with the operations of the New York & Philadelphia Traction Company in New Jersey, more particularly in Middlesex and Somerset Counties. This is the line that stole a march on the authorities a week ago last Sunday by building a connecting line between Somerville and Bound Brook, 2½ miles in length. The construction work was carried on on Sunday in order to avoid an injunction. The bill sets forth that the New York & Philadelphia Company built its track without the consent of the Bridgewater Township Committee, and that the thoroughfare was seized by the railway company without lawful right. The bill prays that the company be restrained from any further construction, and that it remove its present track and restore the highway to its former condition.

Legal Note.

RIGHT OF WAY.—The Supreme Court of the State of Tennessee has affirmed the decision of the lower court in the consolidated causes involving the rights of way on principal streets for street railway purposes. The opinion was in favor of the Knoxville Street Railway Company, and against the Citizens Railway Company.

Personal Note.

MR. JAMES WARNER KELLOGG, of the General Electric Company, Schenectady, N. Y., was united in marriage on October 27 to Miss Louise Cook Pierce, of New Bedford, Mass. Mr. Kellogg is an honor graduate of Lehigh University, his experience beginning in the engine works of the E. P. Allis Company, Milwaukee. He is in charge of the draughting department of the General Electric Company, which is devoted to marine and isolated-plant work. His many friends wish him and his bride a long and happy life.

Trade and Industrial Notes.

MR. C. F. CROSELMIRE, platinum refiner, Newark, N. J., states that he has closed a number of large contracts in the West, where his representative, Mr. C. F. Croselmire, Jr., has been traveling for the past month.

A HANDSOME PICTURE of a lion, taken from nature, is being mailed by the Western Electric Company, of Chicago, to its customers. The picture is a half-tone, printed upon cardboard 11 inches by 14 inches, with a silk cord at the top for hanging.

A NEW ELECTRIC LAMP MANUFACTURING PLANT is to be established at Warren, Ohio, by Mr. C. C. McNutt and others. It is stated that property has been leased by those interested to establish a factory. This new enterprise will be the third of the kind in Warren.

THE MASSACHUSETTS CHEMICAL COMPANY, Boston, Mass., manufacturer of "Insullac" and other well-known insulating compounds, has brought out in circular form a hitherto undiscovered fable of Æsop, the moral of which is that insulation is best made by those having knowledge and experience in its preparation.

MESSRS. SANDERSON & PORTER, 31 Nassau Street, New York City, have closed a contract for the installation of a complete electric-light plant for the town of Randolph, Vt. The contract includes a 6000-volt inductor generator, an 8-mile transmission line, step-down transformers, and a complete system of distribution in the town.

MR. CHARLES WIRT has found it necessary to enlarge his quarters at 1028 Filbert Street, Philadelphia, in order to better handle his increasing business. The Wirt dynamo field rheostat is now ready for the market. Mr. Wirt is manufacturer and dealer in switchboard instruments, special rheostats, dynamo brushes, portable instruments, etc.

MR. J. F. McGUIRE, of the late firm of T. J. Murphy & Co., New York, has established a switchboard business at 801 Greenwich Street, New York. Mr. McGuire was the practical man of T. J. Murphy & Co. While with this firm he designed and built the switchboards made by it. He also designed the M. & M. all-copper switch, which has become well known to the trade.

ELECTRIC SIGNS AT THE CHICAGO HORSE SHOW.—The B. F. Chase Company, sign makers, of Chicago, were the contractors for all the illuminated sign work at the Horse Show held in Chicago. They used exclusively the Sunbeam incandescent lamp, a number of them being the special 4-cp lamps designed particularly for sign work. The Western Electric Company is agent for this lamp.

THE OHIO BRASS COMPANY, Mansfield, Ohio, in its September price list of railway motor metal bearings gives the prices of armature bearings (both ends), intermediate bearings and axle bearings. These bearings are smooth in finish, perfect in operation, accurate in fit and economical in use. The Electric Appliance Company, Chicago, is the selling agent for these goods.

NEW ELECTRICAL SUPPLY HOUSE.—William E. Kline & Co., is the title of a new electrical supply house established at 123 Liberty Street, New York City. Messrs. William E. Kline and Wallace J. Luster are the partners in the new concern. The firm will handle incandescent lamps, making a specialty of miniature and surgical lamps. Both of these gentlemen are young, energetic and popular, and should make a success in their new departure.

MR. CARLOS BRIGHT, Buenos Ayres, Argentine, has just issued a pamphlet, in the Spanish language, giving a list of the various plants installed by himself between July, 1896 and 1897. Mr. Bright may be proud of the record, as the list is a long one. It is given in tabular form, showing the number of lamps, motors, etc., in each installation. Mr. Bright is the representative in Argentine of the General Electric Company, and he carries on a general electrical business.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY has opened a downtown office in New York City at Room 602, Bowling Green Building, 11 Broadway. The company was led to establish this office by reason of the increase of its business in enclosed-arc lamps, and in order to afford greater convenience to its customers. The office is in charge of Mr. Fred E. Dolbier as manager of the arc-lamp sales department. All orders and inquiries regarding these lamps should be forwarded to the new office.

NEW INSTALLATIONS OF THE WEBSTER STEAM-HEATING SYSTEM.—The success and popularity of the system of steam heating installed by Warren Webster & Co., Camden, N. J., may be judged from the following orders received between October 16 and November 5: Carry Apartment House, Washington, D. C.; Babbitt & White Apartment House, Washington, D. C.; Gammon Theological Seminary, Atlanta, Ga.; Eutaw House, Baltimore, Md.; Narragansett Hotel, Providence, R. I.; Cupples Station Buildings, St. Louis, Mo., and the Missouri Medical College, St. Louis, Mo.

MR. M. T. DAVIDSON, 43-53 Keap Street, Brooklyn, announces that after careful investigation and tests of the evaporation water cooler, designed and patented by Mr. E. F. White, of New York, he has completed arrangements by which he will control the building and selling of this apparatus. Mr. Davidson guarantees first-class workmanship and material in its production. Mr. White has charge of this department, and is located at Mr. Davidson's New York office at 133 Liberty Street. Mr. Davidson is prepared to submit estimates for cooler plants from 25 gallons per minute upward.

CIRCUIT-BREAKERS AND SWITCHES.—The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., has just issued two catalogues of the same size and appearance, one dealing with switches for alternating and direct-current circuits for potentials not exceeding 600 volts, and the other with automatic circuit breakers for direct current circuits for potentials not exceeding for potentials not exceeding 750 volts. Illustrations and descriptions of the apparatus of both kinds are given, together with other relevant information. Diagrams show the principal dimensions of the standard circuit breakers.

THE ELEVENTH EDITION of the catalogue of Messrs. W. R. Ostrander & Co., 22 Dey Street, New York City, has just been issued. It is a very complete production, and gives illustrations and prices of the extensive lines of goods handled by this well known firm. Messrs. Ostrander & Co. are manufacturers of speaking tube hardware, electric bell goods, electric light material, telegraph and telephone goods, and general electrical supplies. A very complete index is given at the back of the catalogue, which contains 247 pages. This is one of the oldest electrical supply houses in the city, and its goods represent standard of excellence.

AMERICAN ENGINES IN RUSSIA.—In a recent letter received by the Ball Engine Company, Erie, Pa., an excellent report is given concerning a 400-hp vertical Ball engine, direct connected to a Siemens & Halske generator, now in use at the works of the Nicopol-Mariopol Mining & Metallurgical Company's works in South Russia. Mr. H. S. Loud, general manager of the works, states that the plant is working excellently, and thanks both the Siemens & Halske and the Ball Engine people for the great satisfaction which their machinery has given his company. He states that the workmanship of the Ball engine people is "magnificent."

CHARLES BESELER'S SON recently succeeded to the business of his father at 218 Centre Street, New York City. Mr. Beseler is one of the best-known manufacturers of stereopticons. The house was established twenty years ago by Mr. Charles Beseler, and to-day it enjoys the reputation of producing the very best of goods in its line. This is evidenced by the fact that it has among its patrons the Board of Education of New York City, Columbia University, and other institutions of like prominence. Under the present management the policy established by the elder Beseler is being pursued, and the excellence of the product is being ably maintained.

A NOVELTY in the line of ventilating fans is the production of the Fuller & Curtis Company, Detroit, Mich. One important difference between this fan and the standard fans on the market is in the shape of the blades, which are helical or screw-shaped, and resemble the blade of a propeller wheel. They are claimed to be superior to flat blades. It is stated that active tests show that blades of this shape will move one-third more air than those of the ordinary shape. The Fuller & Curtis Company has adopted the principle of paying all the freight charges and making no charge for boxing. As it manufactures both the fan and the motor it is thus enabled to make liberal allowances in prices and pay freightage, etc.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y., is now manufacturing nearly 1200 different styles of steel-drawn boxes for electrical distribution. The company has just issued a catalogue of these boxes, in which are given descriptions of the boxes, together with diagrams of the various styles produced. The boxes are drawn from one piece of wrought steel, and each style is made in a variety of shapes and sizes to answer different purposes. Every box is coated inside and outside with a heavy black enamel, having special insulating properties. The company also makes a line of cut-outs especially designed for use in connection with its steel boxes. The cut-outs fit inside the box nicely, and are made as convenient as possible for fusing.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued a neat catalogue of its alternating-current motors, switches, switch and tablet boards and miscellaneous supplies. The various devices are illustrated. The Emerson alternating-current motors are designed for fan and power purposes. Their constructional features have already been illustrated and described. These machines are quite popular, and are giving very satisfactory results in practical work. The various designs of switches are illustrated. The company makes a very complete line of switchboards of various sizes. The miscellaneous supply department of this company includes distribution cut-outs, fuse blocks, insulating joints, transformers, switch terminals, connectors, switchboard trimmings, stage regulators, watch demagnetizers, etc.

PARAGON FAN AND POWER MOTORS for direct current are described and illustrated in a catalogue just issued by Mr. J. P. Williams, general agent for these machines at 39-41 Cortlandt Street, New York City. The principal features of these motors are their neatness, compactness, efficiency, durability and reasonable cost. The Paragon products are guaranteed electrically and mechanically, and it is stated that of all the fans used during the year 1897 there is not a record of a single burnout. Paragon motors are finished in six colors, green being the standard color. In the catalogue is given a code for use in ordering Paragon motors of various styles and finish. The details of the motor are well illustrated, from which a very good idea of the construction and operation of the machines may be obtained. Paragon power motors are built with great care, and they are very compact.

VENTILATING FANS.—The C & C Electric Company, New York, makes a special type of motor for direct connection to exhaust fans, and secures the several different speed reductions required through field commutation, the field connections being effected through a special field-switch. For driving blowers the company uses either its enclosed iron-clad or "M. P." motors, running at very low speeds and direct-coupled to the fan shaft, the speed changes being effected in the same manner as in the exhaust wheel motors. During the last few months the C & C Company has installed in Greater New York a very large number of these machines in many of the principal buildings, which have been erected during that period. Among the large buildings thus equipped may be mentioned: The Astoria Hotel, the Delmonico building, the Hearn building, the Brooklyn Armory, the Empire Building, the New York Athletic Club, Columbia University, New York County Bank, St. Bartholomew's Church, and Grace Church.

THE SPRAGUE ELECTRIC COMPANY, New York, has been awarded the contract for nine passenger elevators in the new Exchange Court Building, New York, of which Mr. William Waldorf Astor is the owner. These elevators will be the largest and fastest, of the latest type of the Sprague multiple-sheave and ball-nut machine. In addition the Sprague Company has recently received an order for an additional machine in the Goelet Building, New York, and two machines for the Homer Laughlin Building, Los Angeles, Cal. It has also received orders for its automatically controlled house elevator, for the residences of Dr. Kinnicut, E. W. Bliss and E. B. Van Winkle, and the Harmonie Club, all in New York. The contract for the Exchange Court Building is the first received by the Sprague Electric Company since its organization. This company, it will be remembered, recently absorbed the Sprague Electric Elevator Company, and the Interior Conduit & Insulation. The final details of the consolidation of these two concerns were completed this week.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York City.

DAILY TRAINS TO COLORADO, UTAH AND CALIFORNIA.—Commencing at 10 P. M., September 12, and every night thereafter at the same hour, the Chicago, Milwaukee & St. Paul Railway train will leave the Union Passenger Station (Canal and Adams Streets, Chicago), with elegantly equipped palace sleeping cars for Denver and other Colorado points, with through connections at Denver for Salt Lake City, Ogden, San Francisco and points in Southern California. The route to Denver is via Omaha and Lincoln, Neb., and is first-class in every respect. All the modern facilities of travel are included in this direct route to Colorado—the Eldorado of the West. The allied lines, composing the route, via., the Chicago, Milwaukee & St. Paul Railway—Chicago to Omaha—and the Rock Island & Pacific—Omaha to Denver and Colorado Springs—have united to make this the most popular route to all points west of the Missouri River. For further details, time tables, etc., address E. F. Richardson, General Agent Passenger Department, C., M. & St. P. Ry., 381 Broadway, New York City.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOVEMBER 2, 1897.
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

592,760. GALVANIC BATTERY; H. J. Brewer, New York, N. Y. App. filed April 15, 1893. The combination, of a battery cover having a cup formed thereon, with a battery element passing into said cup and supported therein, and an elastic connection interposed between the head of the cup and the battery element.

592,769. METHOD OF AND APPARATUS FOR RELAYING TELEPHONIC MESSAGES; A. W. Erdman, Milburn, N. J. App. filed July 6, 1897. The method of repeating or relaying the electrical transmission of speech between two circuits, which consists in transforming the electrical undulations of the voice currents in the transmitting circuit into similar mechanical vibrations; in causing these to correspondingly vary the flow and thereby the pressure of a current of air or gas; and in causing the said air-pressure vibrations to correspondingly vary the resistance, and thereby the current of the receiving circuit.

592,782. CHEMICAL ELECTRIC GENERATOR; H. K. Hess, Syracuse, N. Y. App. filed May 7, 1894. The combination, with an electrolyte containing casing or shell, and a series of negative electrodes arranged within the casing or shell; of a series of positive electrodes interposed between the negative electrodes and each comprising an electrical conductor and an active material, inclosing supports for the positive electrodes interposed between the negative electrodes, and a conduit provided with a series of branch passages communicating with the inner chambers of the inclosing supports for discharging the active material therein.

592,805. ELECTRIC LIGHT FIXTURE; F. B. Mason, Brooklyn, N. Y. App. filed March 19, 1895. In an arc lamp, the combination of a pair of carbon holders or brackets, with a shaft provided with right and left hand screw threads, a sleeve screw threaded on the interior to fit said screw shaft, and also screw threaded on its exterior with a thread of a different pitch, to fit a screw thread in one of the brackets, means to secure said sleeve to either the bracket in which it fits or to the shaft, said brackets being mounted on said screws and operated thereby.

592,815. ELECTRIC CONDUCTOR AND CONNECTION AND SUPPORT THEREFOR; W. McElroy, Brooklyn, N. Y. App. filed April 30, 1892. A support for electric conductors, consisting of a supporting piece having a cam projection, in combination with a terminal piece pivotally connected to said supporting piece, adapted normally to be supported thereby, and having an arm adapted to engage with said cam projection upon the tilting of the terminal piece, and thereby to disconnect the latter from said supporting piece.

592,831. ELECTRIC RAILWAY SYSTEM; W. Robinson, Boston, Mass. App. filed Feb. 15, 1895. The combination, of a continuously closed electric circuit, a plurality of electromagnets connected in series and included in said circuit, said magnets being operated without opening the circuits thereof, a source of electric supply furnishing current to said circuit, two lines of contact conductors made in parallel sections normally included in said continuously closed circuit, the source of electric supply being connected to one end of each set or parallel pair, of sections of contact conductors and the respective magnets to the opposite ends of the said respective sets of parallel sections of contact conductors, and means for demagnetizing each of said magnets in succession, independently of the others, by making short-circuiting connection between said parallel sets of sectional contact conductors in succession

592,844. APPARATUS FOR ELECTRICALLY TREATING DISEASES; H. E. Waite, New York, N. Y. App. filed Aug. 11, 1897. In an apparatus for treating disease, the combination, with an air impulse device, of an electric impulse device arranged so that the air and electrical impulses shall be simultaneous.

592,853. ELECTRIC BATTERY; A. D. Wheeler, Hyde Park, Mass. App. filed Jan. 22, 1897. In an electric battery, a cover, consisting of two plates, each having elongated openings extending inwardly from one end, and placed one upon the other, with their openings extending in opposite ways.

592,878. DENTAL ELECTRODE; F. L. Morhard, New York, N. Y. App. filed March 1, 1897. In a dental electrode, the combination, with a conductor having a pocket to hold the anesthetic, of a non-conducting shank adapted for contact with the opposite jaw or tooth.

592,889. DISTRIBUTION BOARD FOR ELECTRIC CURRENTS; H. W. Shonnard, New York, N. Y. App. filed Nov. 17, 1896. In a distribution board for electric circuits, the combination, with the parallel main circuit bars, of branch-circuit bars composed of flexible comparatively thin strips of metal, each passing beneath and connected at one point to one of the main-circuit bars, and arched upward by bending to extend above and cross over the adjacent main-circuit bar and connections therefor directly to the foundation of the board, and electric connections therefrom to the main and branch circuit wires.

592,917. MAGNET ARMATURE; H. M. Paine, Amherst, Mass. App. filed April 30, 1896. An armature in sections or separated parts in combination with a lap joining the sections.

592,923. TROLLEY WIRE HANGER; N. J. St. Hilaire, Gardner, Mass. App. filed June 28, 1897. In a trolley-wire hanger, the combination, with a frame, of jaws fulcrumed in said frame, having upwardly extending ends and provided at their lower ends with recesses shaped to grip a trolley wire, a wedge having a screw threaded portion passing through a screw threaded opening in the upper part of said frame, and means to rotate said wedge and force said jaws to clamp a trolley wire.

592,928. TROLLEY FOR ELECTRIC CARS; E. C. Davis, New York, N. Y. App. filed May 25, 1897. A trolley arm for trolley cars, said trolley arm being provided with a swiveled attachment, which is provided with spring arms, which project parallel, and in the same direction as the trolley arm, said spring arms being provided at their outer ends with a shaft on which a trolley wheel is mounted.

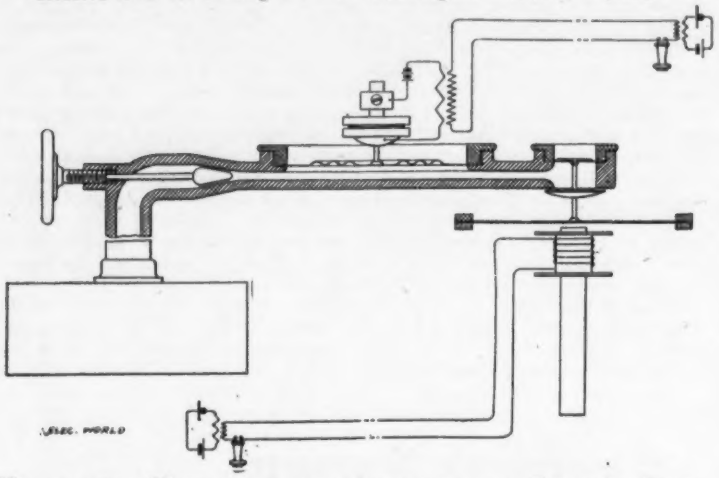
592,930. INSULATING COUPLING; C. F. Hummel, Brooklyn, N. Y. App. filed March 22, 1897. A pipe joint or coupling consisting of two similar coupling heads, each of which is conical in form, and provided with a screw-threaded central bore, at the inner end of which is an inwardly directed annular flange, an insulating plate or disc placed between said coupling heads, an insulating casing mounted on each of said coupling heads, and two sleeves fitted respectively upon said coupling heads over said insulating casings, and one of said sleeves being provided with an annular rim, which is screw threaded and adapted to engage with a corresponding thread formed on the other sleeve.

592,949. WIRE CLAMP; W. H. Brodie, Brooklyn, N. Y. App. filed May 8, 1896. In a wire clamp, the combination of two pivotally connected sections, adapted to clamp the wire, and means comprising a screw threaded part connected to the sections, and a wedging block having screw threads

engaging with said screw-threaded part, said means being arranged for moving said sections into clamping engagement with the wire.

592,951. REGULATING SOCKET FOR ELECTRIC LAMPS; C. A. Chute, East Liverpool, Ohio. App. filed June 14, 1897. In a regulating socket, the combination of a rheostat having a plurality of terminals, a switch-board constructed to support said terminals, a switch adapted to encounter said terminals successively, lamp contacts, one of said lamp contacts being connected with the switch, short circuits connecting said terminals and cut-outs arranged to make or break said short circuits.

592,954. SIGNALING APPARATUS; P. G. Hubert, New York, N. Y. App. filed June 4, 1897. The combination, with a visual signal supported to spring into operative position under the influence of gravity, of a spring-actuated lever for holding the said visual signal concealed, a plunger for



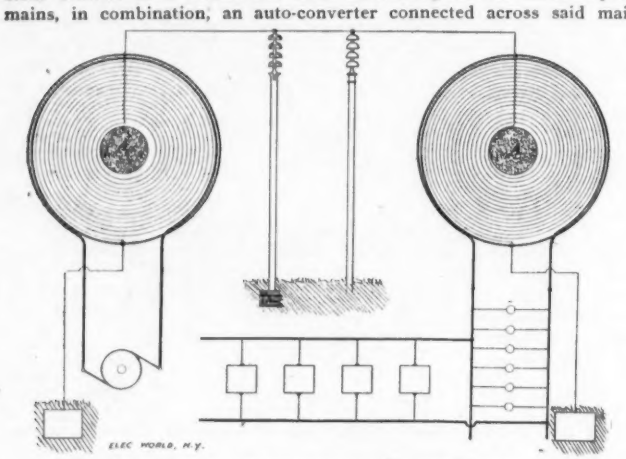
No. 592,769.—Method of and Apparatus for Relaying Telephonic Messages.

operating said lever, a push button for operating the plunger, a signal located at a distance from the said visual signal and means under the control of the push button for operating said distance signal simultaneously with the operation of the said plunger.

592,962. ELECTRIC-SIGNAL APPARATUS; F. W. Cole, Newton, Mass. App. filed March 10, 1896. The combination, with an electric circuit, code signal and telephonic transmitters therein, for sending two different classes of signals over said circuit, viz., code signals and telephonic messages, code signal and telephonic receivers, responsive respectively to said transmitters, and automatic switches for said telephonic transmitters operated by any one of said code-signal transmitters in the circuit.

592,965. ELECTRIC MOTOR FOR STREET CARS; C. E. Emery, Brooklyn, N. Y. App. filed Oct. 15, 1892. An electric-motor frame in the general form of a cup or cradle, capable of being made fluid tight, with the ends raised above the centre to receive pole pieces, and with the sides forming the field yokes cut down at the armature-shaft bearings.

593,050. ALTERNATING-CURRENT REGULATOR; D. O. Hull, Clyde, Ohio. App. filed Oct. 17, 1895. In an apparatus for maintaining a constant current in a circuit fed from alternating-current constant-potential mains, in combination, an auto-converter connected across said mains, a



No. 593,138.—Electrical Transformer.

row of contact pieces connected with the windings of said auto-converter, a movable brush adapted to contact with any of said contact pieces, the circuit to be controlled connected at one terminal with one of the mains and at the other with said brush, an induction motor, and a solenoid, both connected in said circuit, a reversing motor switch connected in the circuit between the solenoid and motor, mechanism connecting the movable part of said switch with the armature of said solenoid, and mechanism for transmitting motion from the motor to the converter brush.

593,051. ELECTRIC RAILWAY; R. M. Hunter, Philadelphia, Pa. App. filed Sept. 23, 1896. In an electric railway, the combination of a slotted conduit, a flexible conductor within the conduit, a traveling car, stationary insulating supports within the conduit for said conductor and a grooved current-collecting device making a running contact with the conductor and arranged adjacent to the plane of the slot of the conduit.

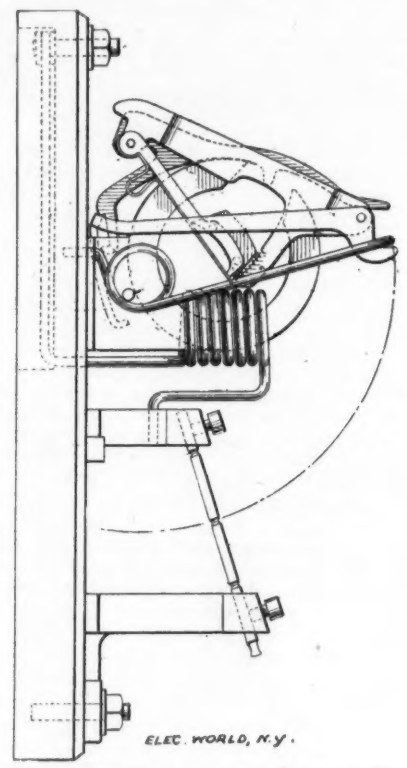
593,094. TYPEWRITING TELEGRAPH; L. R. Hammond, New Haven, Conn. App. filed May 18, 1896. The combination, with a revoluble type wheel or segment bearing the character to be printed, and a carriage for supporting the paper adjacent to said type wheel, of a pivoted impression hammer, a revoluble selector disc carrying radially movable tappets, which are adapted in one of their positions to actuate said hammer, a selector hammer, a selector lever for imparting radial movement to said tappets upon said disc, a rack-bar operatively connected with said selector lever for moving the latter, a shaft having gear connection with said rack-bar and carrying a pulley, a cord and weight for revolving it in one direction, an escapement mechanism governing the movement of said shaft, an electro-magnet and armature for operating said escapement mechanism, a series of keys bearing characters corresponding to those on said type wheel, and a series of circuit closers, operated by said keys, for closing the circuit through said magnet.

593,138. ELECTRICAL TRANSFORMER; N. Tesla, New York, N. Y. App. filed March 20, 1897. A transformer for developing or converting currents of high-potential, comprising a primary and secondary coil, one terminal of the secondary being electrically connected with the primary, and with earth when the transformer is in use.

593,143. ELECTRIC-RAILWAY SYSTEM; H. P. Wellman, Ashland, Ky. App. filed May 26, 1897. An electric-railway system, comprising a sectional conductor, a feed-in switch for each section for controlling the electric current thereto, a transformer or converter initially partially charged by the alternating current of one section of said conductor, and having its magnetic circuit normally incomplete or interrupted, and means for temporarily completing said magnetic circuit, whereby said transformer will operate the same feed-in switches.

593,154. CURRENT-COLLECTOR FOR ELECTRIC RAILWAYS; F. A. Anderson, Washington, D. C. App. filed Oct. 12, 1897. In a current collector, a standard comprising a plurality of frame bars, conducting bars arranged between the frame bars and insulated therefrom, terminals arranged at the top of the standard, fuse blocks arranged in the upper portion of the standard and having recesses in which the upper ends of the conducting bars and the lower ends of the terminals are housed, whereby to insulate these parts from each other, fuses arranged exteriorly of the sides of the fuse blocks and on opposite sides of the standard, and means to permit the ready removal and replacement of the fuses.

593,167. ELECTROMAGNETIC CIRCUIT BREAKER; D. C. Spruance, Philadelphia, Pa., and Montgomery Waddell, New York, N. Y. App. filed Jan. 25, 1897. The method of opening an electric circuit which consists in



No. 593,167.—Electromagnetic Circuit Breaker.

mechanically breaking out by a hammer blow a section of the circuit from between two terminals and simultaneously breaking the removed section into a plurality of parts.

593,172. CARBON-HOLDER FOR ARC LAMPS; C. C. Bailey, Woonsocket, R. I. App. filed Feb. 26, 1897. In a carbon-holder for electric-arc lamps, the combination of an apertured carrier, carbon-holding jaws adjustably connected together, one of said jaws extending loosely through the aperture of the carrier and adapted to bear against the under side of the same, a yoke lever, comprising two members resting on opposite sides of said jaw and pivotally and detachably connected to the same and adapted to bear at one end upon the carrier, and having coincident threaded apertures at their opposite ends, and the adjusting screw taking through said apertures and impinging upon the upper side of the carrier, and serving also as a hinge pinle for the yoke members.